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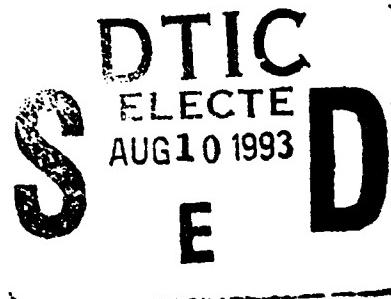
**ANALYSIS OF BOLTED AND BONDED  
COMPOSITE JOINTS**

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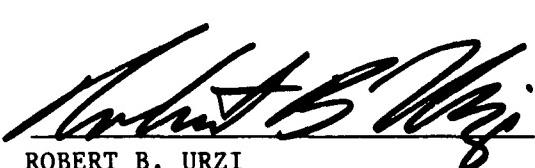


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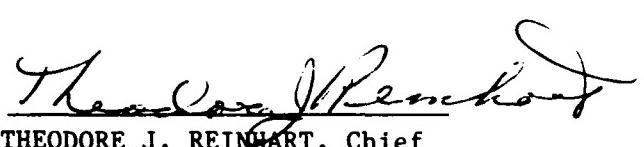
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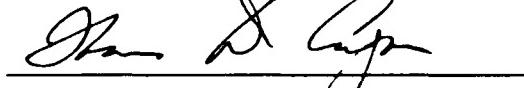
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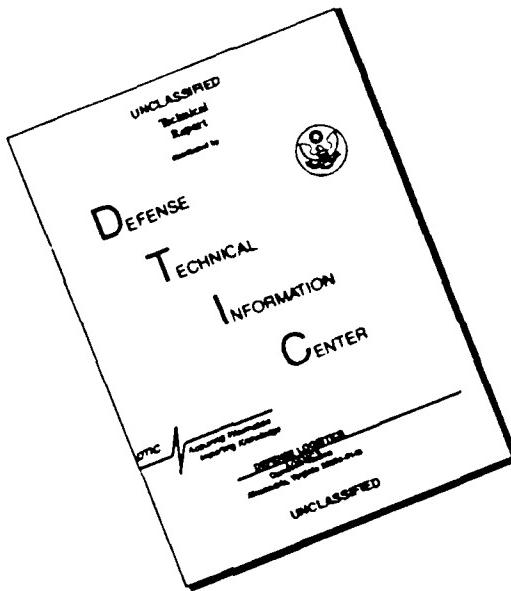


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<p>In the analysis and design of bonded and bolted composite joints, certain input data are required that are not readily available. Many engineering hours at the depots are expended in obtaining the required information. Even when the data are obtained, the accuracy of it is sometimes questionable. The availability of this information in a computerized database would greatly facilitate composite joint analysis and design.</p> <p>The work described in this report involved an extensive search of the technical literature for adhesive and composite material property data as well as bonded and bolted joint properties. The data collected in the literature search were tabulated into a user friendly format for ready retrieval.</p> <p>The data in this tabulation include, in addition to material properties, discussions of fastener and joint design parameters, loading and environmental effects and test methods.</p>			
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Bolt Pattern	Fastener	Mode II
Bolted	Fatigue	Mode III
Composite	Hybrid	Properties
Creep	Joints	Shear
Database	Lamina	Stress Relaxation
Design	Lap Shear	Stress-Strain
Effects	Loading Types	Test Methods
Elevated Temperature		

## PREFACE

This report covers work performed during the period from May 1991 to June 1992 under Air Force Contract F33615-89-C-5643. The work was performed by Wright Materials Research, evaluated by the University of Dayton Research Institute, and administered under the direction of the System Support Division of the Wright Laboratory, Wright-Patterson Air Force Base, Ohio. Mr. Robert Urzi was the program Project Engineer. The author would like to thank Capt. R. Keller of SM-ALC/TIEC, Mr. R. Askins of the University of Dayton Research Institute, Mr. J. Mazza, Mr. N. Ontko and Mr. M. Forte of WL/MLSE for the review of this report.

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# **Chapter 1**

## **Bolted Joints in Laminated Composites**

### **1.1 INTRODUCTION**

The study of bolted joints of laminated composites consisted of a literature search in the following publications: Composite Structures, Composites, Journal of Composite Materials, American Society For Testing and Materials (ASTM) Special Technical Publication (STP), AIAA Proceeding and Journal of AIAA, Proceeding of Society of Experimental Mechanics, NASA Technical Reports, Air Force Technical Reports and the technical reports from National Laboratories. A listing of all documents researched on bled joints is included at the end of this chapter.

It is commonly believed that adhesive joints in structures can provide higher efficiency than those of mechanical joints. However, there are many reasons why mechanical joints will continue to be used as long as assembly is needed in a structure. Mechanical joints are practical, easy to use, do not require special surface preparation as adhesive joints do, and are timely and cost effective. In some cases, such as joining of thick composite components, mechanically fastened joints are preferred over adhesive joints. Sometimes mechanically fastened joints are required; for instance, in the assembly of demountable components. Battle damage repair, References [1-1 to 1-3], also requires mechanically fastened joints since they cannot use any major equipment that is not accessible in combat conditions.

Mechanical joints generally include bolts, screws and rivets (or pins). Bolts are mainly used in highly loaded structures such as aircraft. Screws are mainly used for joining composites with wood and pins are suitable for assembling temporary structures or structures that do not require high level of load transferring between the components.

Composite aircraft structural components that transfer high level of loads through the joints use bolts extensively. The applications of bolts include wing

structures [1-4], fuselage structures [1-5], tail structures [1-6], and many others [1-7 to 1-11].

Early work on bolted joints in composites was confined to a single bolt (commonly referred to as single-bolted joints) and was based on the assumption that multiple bolts (normally referred to as multiple-bolted joints) may be regarded as being a number of bolts loaded in parallel. Recent studies showed that the stress distribution around a joint in a laminate was influenced by its surrounding joints. Thus, not only the stress concentrations but also the failure modes were different to some extent, for a single-bolted and a multiple-bolted joint in composite structures. The bolted joint problems in composite structures deserve continuing attention and study because their performance and behavior cannot be translated directly from isotropic materials. The stress concentrations in composite structures due to bolted joints could be considerably higher than those in structures with isotropic materials due to composite directional anisotropy. In addition, composite materials are brittle, a condition that can cause catastrophic failure. Tailoring the design in composite structures is frequently needed to create a safe structure while maintaining the objective of reducing structural weight.

In 1980, Godwin and Matthews [1-12] wrote a review paper in the area of strength of single-bolted joint in composite laminates. Their discussion covered material parameters, fastener parameters and design parameters. The majority of the work reviewed was published in the European countries, especially the United Kingdom. In this report, we will discuss the work on single-bolted joints and multiple-bolted joints in laminated composites, including some additional parameters that were not considered in Ref. [1-12]. Moreover, the materials discussed in Reference [1-12] are mostly glass fiber reinforced epoxy or glass fiber with polyester matrix while this report discusses many laminates made of graphite fiber reinforced epoxy matrix that is commonly used in many aircraft structures.

## 1.2 MAJOR PARAMETERS

Bolted-joints in laminated composites involving non-uniform through-the-thickness stress distributions and failure mechanisms in a progressive manner are complicated issues. The study of this problem can generally be classified into five main aspects. They are: (1) material parameters (2) fastener parameters (3) design

parameters (4) loading parameters and (5) environment parameters. Each parameter includes several aspects that are discussed in the following.

**Material parameters.** This includes fiber type and form (such as unidirectional, particulate, woven fabric, etc.), resin type, fiber volume fraction of a laminate and the physical and chemical properties of the fiber-matrix interface.

**Fastener parameters.** This includes fastener type (bolt, screw, pin, etc.) and material, fastener size and mechanical properties, fastener clamping pressure, fastener-hole tolerance as well as washer size.

**Design parameters.** This includes joint type (such as single lap, double lap, strap joint, etc.), laminate geometry which includes thickness, end distance to hole diameter ratio, side distance to hole diameter ratio, thickness-to-hole diameter ratio, pitch, back pitch, hole pattern (single hole, multiple holes in a row, in parallel or rows and parallels, staggered rows, etc.) and hole size.

**Loading parameters.** This includes the direction of loading: tension (apply pulling forces between two or more loading surfaces), compression (apply pushing forces between two or more loading surfaces), bearing-bypass loading (the load of the fastener can be applied in any direction regardless of the grips), fatigue loading, impulse loading, creep and relaxation, etc.

**Environment parameters.** This includes steady-state testing environment at room temperature, elevated or cryogenic temperature, thermal spiking, moisture content in the laminates, etc.

**Human and machining parameters:** Technicians can cause some errors in drilling holes and in the process of bolt installation. Likewise, machining tools present problems of accuracy and malfunction.

These parameters will be discussed with experimental data in a later section.

### 1.3 JOINT CONFIGURATIONS

The geometry of a typical single-bolted joint is described in Figure 1-1 where:

$e$  = end distance (distance between the hole center and the end of the plate);

$D$  = hole diameter;

$t$  = laminate thickness;

$W$  = laminate width;

$L$  = length of the laminate.

The configuration of a typical multiple-bolted joint is described in Figure 1-2. In addition to the parameters given above, the following definitions are used to describe the joint:

$p$  = pitch (distance between two bolts in a row);

$L_{i,j}$  = back pitch (distance between two bolt holes in parallel,  $i$  and  $j$  rows);

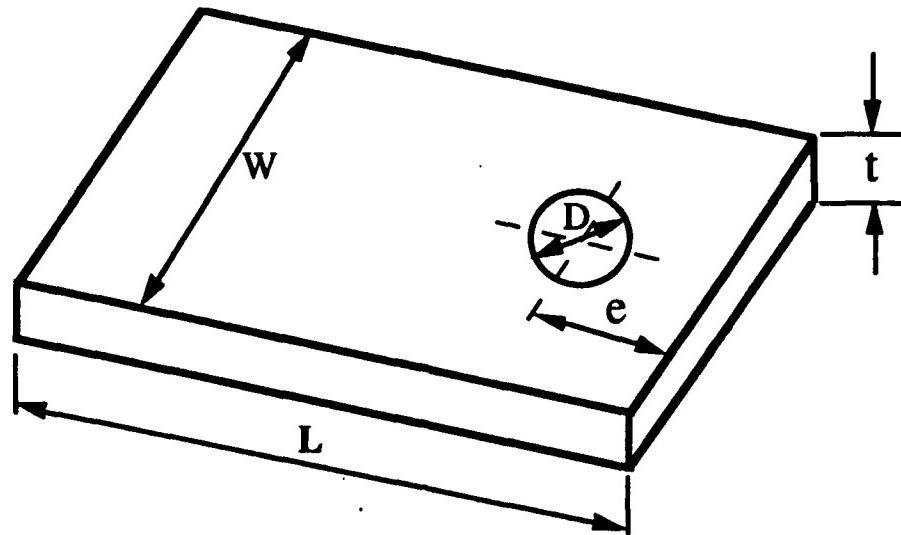
$s$  = side distance (distance between the laminate edge and the first hole center).

These definitions will be used throughout this report. Single-bolted and multiple-bolted joints can be applied in both single lap (shear) and double lap (shear) fashion. Other types of joints can be found in References [1-13] and [1-14].

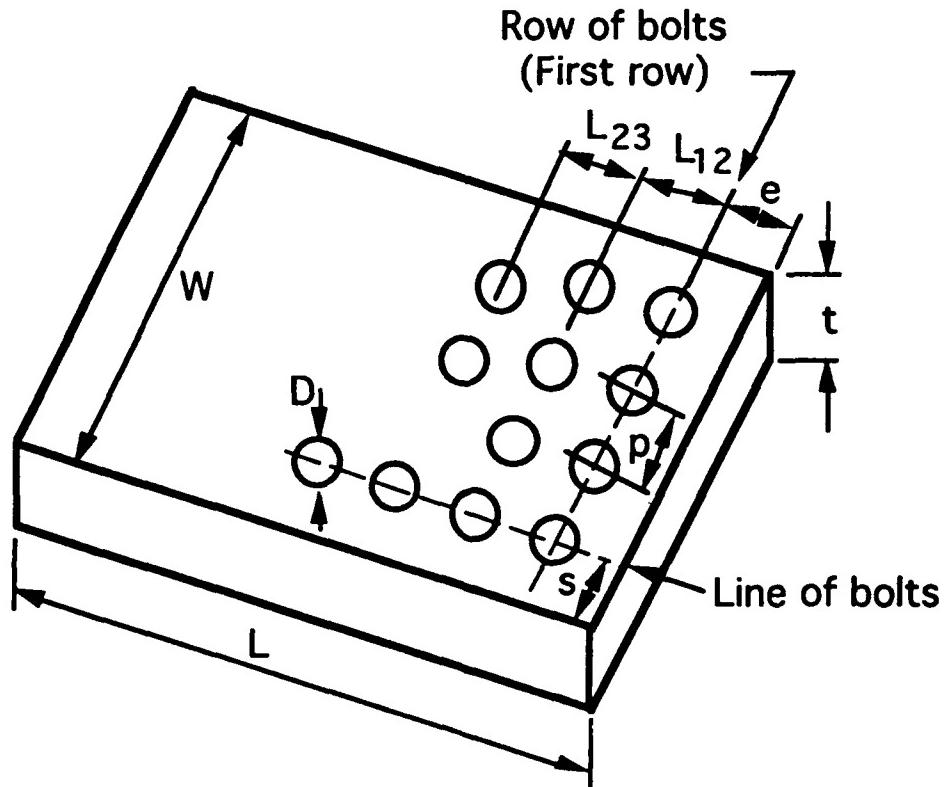
#### 1.4 FAILURE MODES

The most basic failure modes of composite laminates with a single-bolted joint loaded in tension include tension, bearing, shear-out and cleavage, Figure 1-3. Another failure mode in composite laminates that is bolt related will be discussed in Fig. 1-7. Under compression loading, the most frequent observed failure modes are compression through the hole and bearing. Generally, failure modes depend on  $e/D$  and  $W/D$  ratios, bolt tightening pressure and washer size as well as the fiber orientations of the laminate. The tension failure mode normally occurs when the  $W/D$  ratio is small. Bearing mode may occur for large  $W/D$  and  $e/D$  ratios (larger than or equal to 4). Shear-out mode is likely to occur when  $e/D$  ratio is smaller than 3. Cleavage is generally associated with bending in a laminate with small end and side distances. Experimental observations have shown that composite laminates often fail in mixed-mode rather than in a simple mode. For instance, any laminate may suffer bearing failure to some degree even if the dominating failure mode is not bearing.

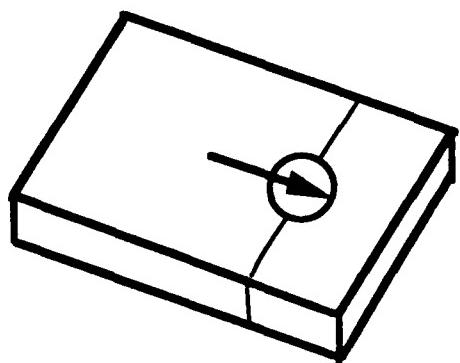
The basic failure modes in composite laminates with multiple-bolted joints are the same as those for single-bolted joints. However, because of the stress interaction between the holes, the global failure mode exhibits some differences from that with a single-bolted joint. In some cases, the dominating failure modes in composite laminates with single-bolted and multiple-bolted joints could be different. Experimental results have shown that tension (or compression) normally



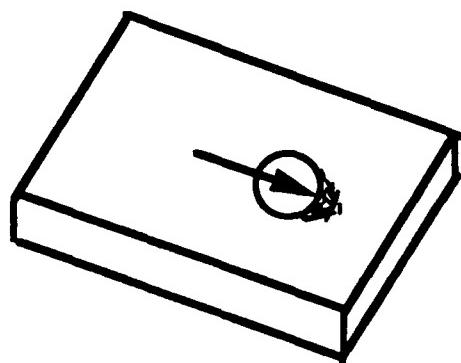
**Figure 1-1.** A typical specimen with single-bolted joint.



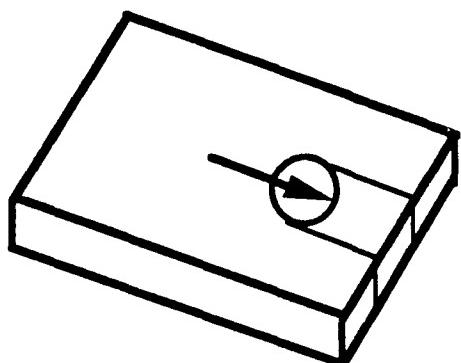
**Figure 1-2.** One definition of multiple-bolted joints. Rows 1 and 2 are in uniform rectangular pattern, rows 2 and 3 are staggered.



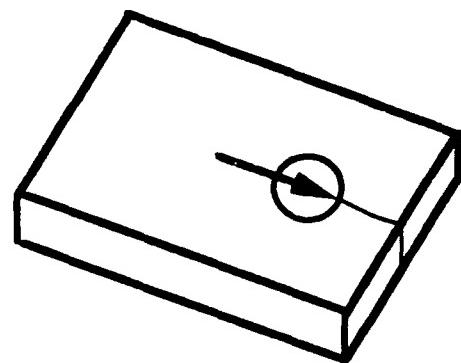
(a) Tension



(b) Bearing



(c) Shear-out



(d) Cleavage

**Figure 1-3. Basic in-plane failure modes of bolted joints in laminated composites.**

occurs with or without the accompaniment of other failure modes in composites with multiple-bolted joints. For single-bolted joints, tension may not occur for large W/D ratio.

The influence of the major parameters described in Section 1.2 on the failure modes of composite laminates will be described in a later section.

## **1.5 THE INFLUENCE OF EACH PARAMETER**

The influence of each parameter described in Section 1.2 on the bolted joints of composite laminates will be discussed in the following.

### **1.5.1 Material Parameters**

The discussions of material parameters include the material forms, the effect of hybrid materials and the effect of woven fibers.

#### **1.5.1.1 Material Form**

Aircraft and aerospace grade polymeric composites are normally made from unidirectional prepreg with either graphite or glass fiber to produce laminates of graphite fiber reinforced epoxy (Gr/Ep) or glass fiber reinforced epoxy (Gl/Ep). Kevlar fiber may also be used to produce laminates of Kevlar fiber reinforced epoxy (Ke/Ep).

Ground transportation and structural grades of polymeric composites are normally made from different matrix materials than those for aircraft structures. Glass fiber is often used with polyester and polyurethane to produce laminates of glass fiber reinforced polyester (Gl/Pe) or glass fiber reinforced polyurethane (Gl/Pu).

The fibers used in aircraft and ground structures normally have different forms. Those used in aircraft structures usually are unidirectional whereas those used in ground structures are normally either in random or in woven form. On the other hand, some of those used on water, such as boats, are frequently in chopped form. The influences of bearing strength due to hybrid materials and woven fibers are discussed in the following subsections.

### **1.5.1.2 Effect of Hybrid Material**

The European countries have studied extensively the bolted joint problem with GI/Ep and GI/Pe laminates rather than Gr/Ep. Many experiments were conducted in the 1960's and early 1970's [1-15]. The bearing strength of laminated composites are in the order of Gr/Ep>GI/Ep>GI/Pe as shown in Figure 1-4. Some investigators have also studied the bolted joints of hybrid composites with GI/Ep and Gr/Ep preprints [1-16, 1-17]. The results show that hybrid composites do not improve the bearing strength [1-16], Figure 1-5. However, they show less brittle failure characteristic in contrast to all-carbon laminates. It also appears that 20% of reduction in bearing strength is compensated with a cost saving because of using GI/Ep rather than all Gr/Ep composites.

### **1.5.1.3 Effect of Woven Fibers**

Experimental results on bolt bearing in woven laminates is extremely limited. From the work of Matthews [1-18], we find that the bearing strength of woven laminates generally follows the same trend as those with continuous straight fibers. However, we believe that their failure sequence and damage modes will be different.

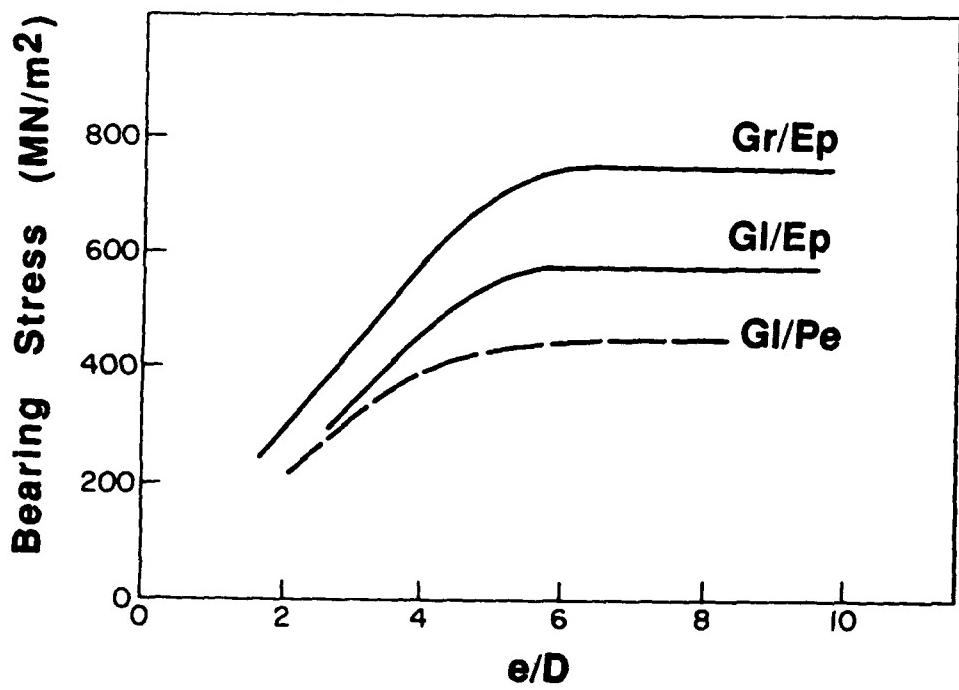
## **1.5.2 Fastener Parameters**

Mechanical fastened joints can generally be classified into three kinds: screws, rivets and bolts for nonmetallic materials.

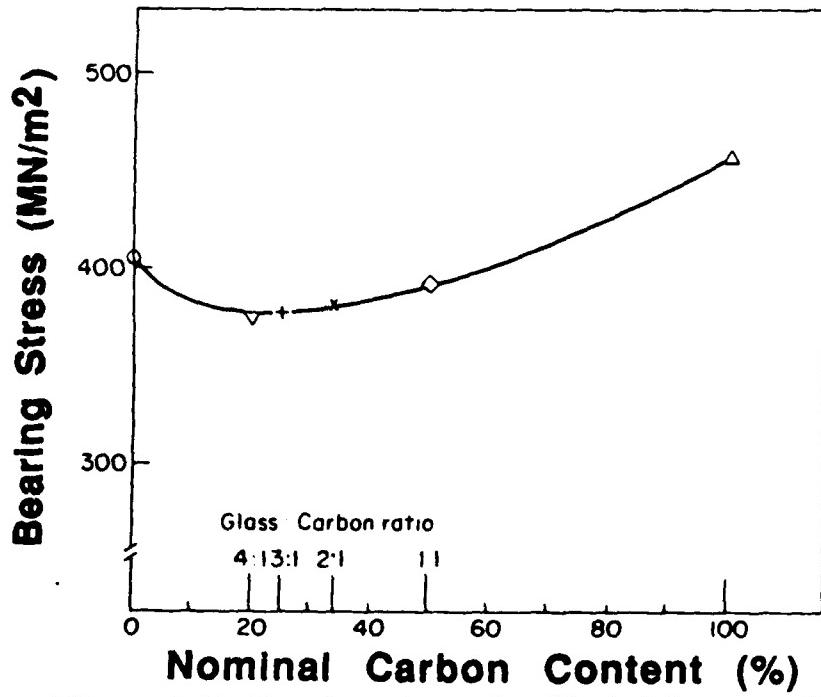
### **1.5.2.1 Characteristics of Mechanical Fastener Joints**

**Screw Joints.** Among the three kinds of mechanical fastener joints, *screws* offer the lowest load-carrying capability. They often cause damage to the laminates in the process of being installed. Therefore, the applications of screws have been limited to joining composites with woods in most cases. One exception is the self-tapping titanium screw [1-19], developed by Kaynar (Figure 1-6), which has been used as an anti-peel fastener for the adhesive-bonded stiffeners of the Tomahawk composite wing. Screw joints of GI/Pe laminates were reported in SPI handbook [1-20].

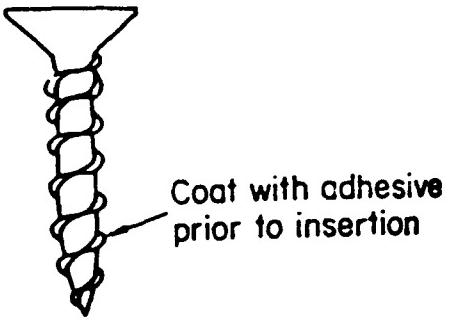
**Rivet Joints.** Rivet joints were used much more often in metals than in polymeric composites. The laminates being joined by rivets are generally thinner



**Figure 1-4.** Bearing strength with e/D ratio of a cross-plyed laminate of Gr/Ep, Gl/Ep and Gl/Pe [1-16].



**Figure 1-5.** Bearing strength of hybrid composites with varying glass:carbon ratio.



**Figure 1-6. Self-tapping screw.**

than 3 mm (0.118 in). The riveting operation can be performed much faster than the other two joining methods. However, it is done in a way similar to impact loading of a laminate. Delamination and split out on the backside from the impact forces as well as some other local damage can be formed around the rivet hole. Due to the nature of the riveting process by rivet guns, the closing force is not readily controlled. Because of the potential problems they might cause, rivet joints in composite structures are not recommended. More discussion of riveted joints in Gr/Pe composites is given by Rufolo [1-21].

**Bolted joints.** Bolted joints offer the greatest load-carrying capability in composites among the mechanical fastener methods. The holes are drilled in a separate process from the installation. If the holes are prepared carefully and with appropriate machining tools, no damage will be caused to the composite structures. This should be emphasized as critical and is a manufacturing science in itself. The drawback is that the cost is the highest among the three kinds of mechanical fasteners. During the past two decades, considerable numbers of studies have been done in the area of bolted joints of laminated composites. Bolted joints are perhaps the best method for joining demountable components of aircraft and aerospace structures. Washers are normally used with bolted joints. Their function is to spread the tightening pressure more evenly and over a bigger area. The significance of applying tightening pressure through the bolts and washers will be discussed in a later section.

***Special Fasteners.*** Fasteners other than the above three basic kinds are referred to as special fasteners. Special fasteners include Hi-Lok, Bigfoots, semi-tubular rivets, Cherry Buck rivet, stress-wave rivet system, groove proportioned lockbolt (GPL), composite fasteners and self-tapping screw. All these special fasteners were designed for use in composite structures. The GPL fastener system is an all-titanium permanent fastener. The primary advantages of the composite fasteners [1-22] are total galvanic compatibility, low cost and high stiffness-to-weight ratio.

#### **1.5.2.2 Fastener Problems**

There are four primary problems associated with bolted composite joints. These are galvanic corrosion, galling, installation damage and low pull-through strength.

***Galvanic corrosion.*** The basic driving force of the galvanic corrosion reaction is the difference in electrode potential between the Gr/Ep and the metals [1-23]. Prince [1-23] suggested the use of protective coatings to protect against galvanic corrosion. He concluded that this method did not work when flaws exist. A comparison of galvanic compatibility between fasteners and composite materials is listed in Table 1-1 [1-24].

***Galling.*** This problem often occurs during the installation of some threaded fasteners in composite joints. One example is the application of titanium or A286 nuts with high prevailing torque titanium fasteners (e. g., Hi-Lok). The nuts and the fasteners tended to lock-up during installation, before the desired pre-load was applied.

***Installation damage.*** Forcing fasteners into an interference-fit hole of a laminate can cause the plies in the backside to delaminate. This is not to imply that interference-fit is harmful to composite structures. Limited experimental data have shown that joint strength of composite structures can be improved with interference. In the process of most rivet installation, the hole is completely filled by the shank expansion. This operation also creates interference-fit and it causes delamination and ply buckling for GI/Ep laminates. The damage caused by interference-fit can be reduced or eliminated if appropriate fasteners are used. For instance, this problem can be overcome using the Stress-Wave rivet system and a Rivnut developed by Goodyear (both are not popular). Another kind of damage that can easily be formed is due to impact forces in installation. One example is

**Table 1-1. Comparison of galvanic potential of fastener materials with composites.**

Fastener Material	Compatibility with Gr/Ep Composites
A286	Acceptable
Aluminum	Not compatible
Cadmium	Not compatible
Chrom. plate	Adequate with A286, PH13-8MO
INCO 600 (Cobalt alloys)	Good
Low alloy steel	Not compatible
Magnesium alloys	Not compatible
Martensitic stainless steel	Not compatible
Monel	Marginal
MP-35N (Nickel)	Good
PH13-8MO (Molybdenum alloys)	Acceptable
Silver plate	Adequate with A286, PH13-8MO
Titanium and its alloys	Very good
Zinc plate	Not compatible

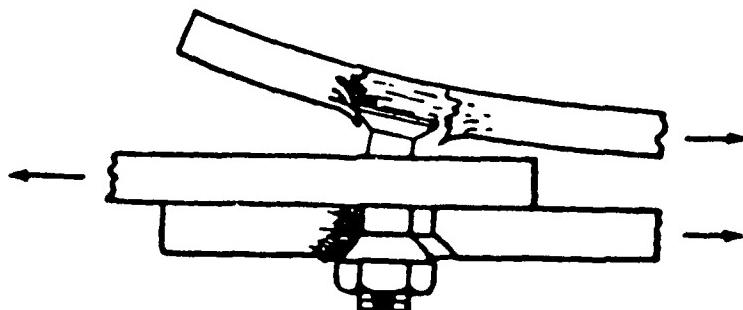
the use of a conventional riveting gun. Delamination, fiber-matrix splitting and fiber breakage may be formed on the backside of the hole.

**Low pull-through strength.** It is well known that composite structures have low pull-through strength. The failure mode is illustrated in Figure 1-7 [1-25]. One remedy to this problem is to use fasteners with enlarged footprints and enlarged heads.

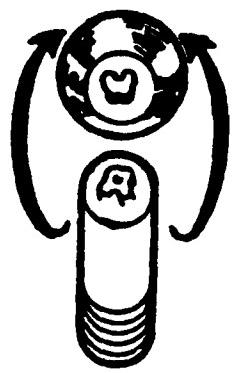
### 1.5.2.3 Fastener Materials and Failure Modes

Metal fasteners are commonly made of steel, titanium or aluminum. Their tensile moduli are 30, 16 and 10 msi, respectively. The range for tensile strengths of steel and titanium bolts is approximately 220 to 160 ksi. The test data of Reference [1-25] show that the steel fasteners result in slightly higher gross strengths compared to titanium fasteners. However, the incompatibility of the galvanic potential between the uncoated steel and the graphite/epoxy materials [1-23] suggests that galvanic corrosion will be a potentially serious problem. Therefore, titanium fasteners are commonly recommended because of their galvanic compatibility with graphite/epoxy materials. The galling problem caused by titanium fasteners and A286 nuts in the situation of high prevailing torque can be solved with proper design of the fastener system.

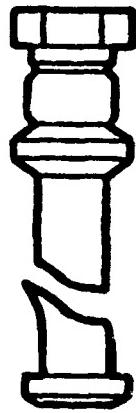
In some cases, bolt failure was observed before the composite structures failed [1-25]. The basic failure modes of the bolts include: (1) the neck (juncture of head and shank) fails in tension and (2) shank fails in shear, Figure 1-8.



**Figure 1-7. Failure mode of bolt pulling through laminate.**

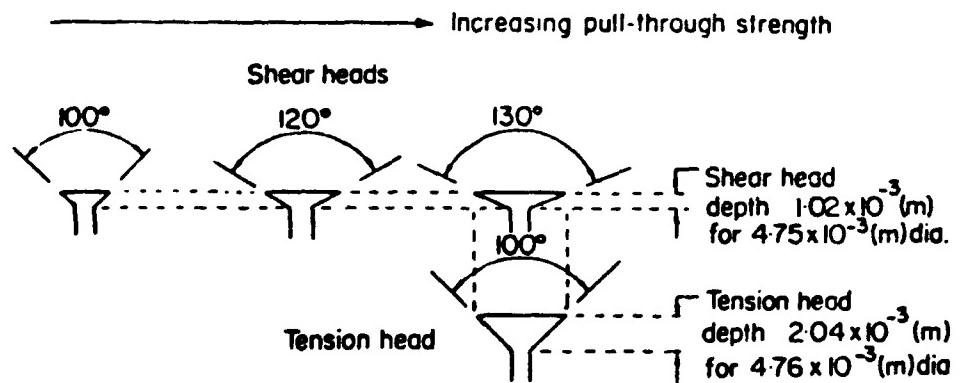


(a) Tension failure



(b) Shear failure

**Figure 1-8. Bolt failure modes.**



**Figure 1-9. Countersink tension head and shear head design.**

#### **1.5.2.4 Effect of Fastener Head and Countersink Angle**

The head designs of the bolts include protruded, tension and shear configuration. The depth of a tension head is twice that of a shear head, Figure 1-9. Ramkumar and Tossavainen [1-25] demonstrated that protruded head fasteners yield higher bearing strengths compared to flush head fasteners (up to 23% difference). Because of aerodynamic stability, flush head fasteners need to be used to maintain flush outer surfaces on a structure. Cole et al. [1-19] demonstrated that 100° tension head fastener joints yield higher laminate bearing strengths compared to 100° shear head fastener joints under static loading. They also found from fatigue tests that the 100° tension flush-head is the best configuration for strength and durability as opposed to the 100°, 120° or 130° shear flush configurations. The minimum head thickness for 100° countersink was recommended by Dastin [1-14] for fastener diameters ranging from 2.38 mm (3/32 in) to 9.52 mm (3/8 in).

#### **1.5.2.5 Effect of Interference-Fit and Bolt Clearance**

Garbo and Ogonowski (1981) [1-26] conducted an experiment using Gr/Ep (AS1/3501-6) [45/0/-45/0/90/0/45/0/-45/0]s (50/40/10) and [45/0/-45/0/45/90/-45/0/ $\pm$ 45]s (30/60/10) laminates with 0.003 and 0.008 in of interference-fit. They concluded that these laminates are insensitive to these interference-values at room temperature dry conditions. At elevated temperature wet (ETW) conditions (250° F and approximately 0.9-1.0% moisture by weigh) the joint strength of the first laminate was increased by 8-15% at both levels of interference. The change in the joint strength for the second laminate ranged from -1.8 to 4.6% at the ETW condition. Other people claimed that interference-fit can improve the fatigue life of composite structures.

Rowlands et al. [1-27] showed that bolt clearance has significant effects on the radial stress distribution of wood. The radial stress component,  $\sigma_r$ , can be reduced by as much as five times when the bolt/hole ratio increases from 0.824 to 0.988. Since no test data were provided, the effect of bolt clearance on the bearing strength is not clear.

### **1.5.3 Design Parameters**

The bolted-joint strengths of laminated composites are affected by many parameters from the designer point of view. The effect of each parameter will be

discussed separately in the following.

### 1.5.3.1 Effect of Clamping Pressure

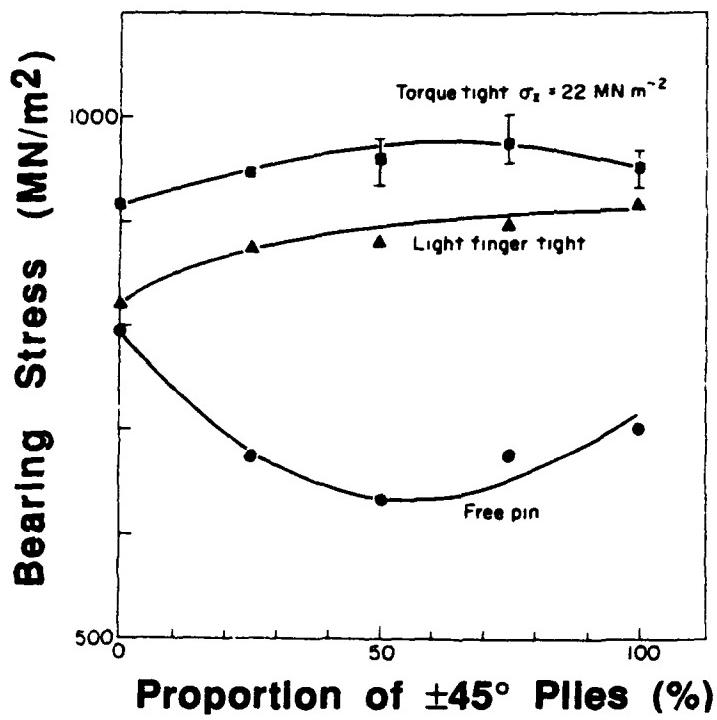
An increase in the fastener torque increases the friction between the structural components, and increases the rotational constraint of the fasteners. This lateral constraint prevents the delamination and ply buckling failure modes under the washer area. It also changes the failure mode around the joint area. Stockdale and Matthews [1-28], Collings [1-29], Collings [1-30] (Figure 1-10), Kretsis and Matthews [1-31] (Figure 1-11) and Godwin et al. [1-39] all show that clamping pressure can significantly increase the bearing strength of Gr/Ep, Gl/Ep and Gl/Pe laminates with single-bolted joints. In fact, even the restraint offered by a finger-tight bolt and nut can improve the bearing strength considerably [1-12] compared to a pin-loaded hole. Ramkumar and Tossavainen [1-25] show that fastener torque only has little effect under tensile loading. However, under compressive loading, the bearing strength increases by approximately 30% when the fastener torque is increased from 0 to 200 in-lbs.

The improvement of the bearing strength due to the lateral restraint could be explained by the change in laminate failure mode. Crews [1-32] reported that the failure mode is bearing under pin bearing condition. Under a moderate clampup condition, the failure mode is shearout under the washer and bearing outside the washer area. In the case of a high clampup condition, a mixed-mode of tension and shearout occur under the washer and bearing outside the washer area.

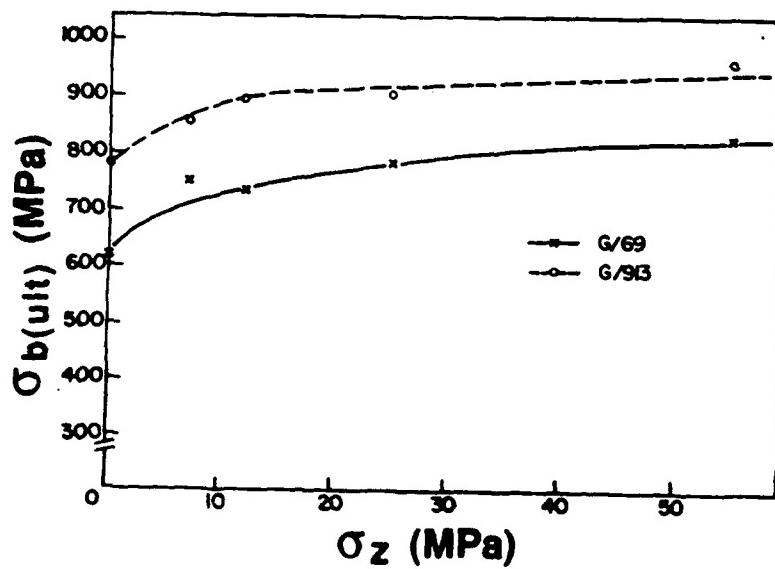
Beyond a certain value of clamping pressure only little increase in bearing strength is obtained. This value depends on the material system and laminate layup. It ranges from 15 MPa [1-31] for Gl/Ep  $[0/\pm 45]_S$ , 22 MPa for Gr/Ep [1-30] to over 90 MPa [1-28] for Gl/Ep. It is noted, however, that at a much higher clamping load compressive damage could be done by washers or fastener heads digging into the laminate.

### 1.5.3.2 Effect of Joint Eccentricity

Joint eccentricity (bending) can be produced by single lap tests. The significance of this effect can be studied by comparing single lap test results with double lap test results. The tests with Gr/Ep (AS1/3501-6)  $[(45/0/-45/0)_2/0/90]_S$ ,  $[45/0/-45/0_3/90/0_3]_S$  and  $[45/0/-45/0/45/90/-45/0/45/-45]_S$  laminates [1-25] reveal that the bearing strength of the first two are relatively unaffected by the change of a



**Figure 1-10.** Effect of bolt tightening pressure on the bearing strength (double lap) of Gr/Ep HTS/914 [ $0_m/\pm 45_n$ ]<sub>s</sub> laminates. D=6.35 mm (0.25"), W=50 mm (1.97")

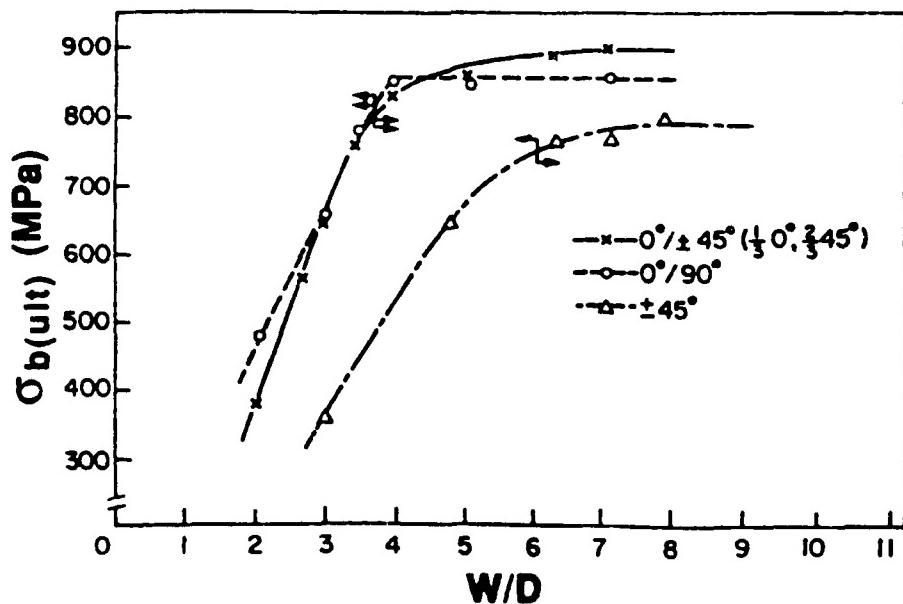


**Figure 1-11.** Effect of bolt clamping pressure on the bearing strength (double lap) of GI/Ep [0/ $\pm 45$ ]<sub>2s</sub> laminates. D=6.35 mm (0.25"), t=3 mm (0.12").

single shear to a symmetric double shear test configuration. The third one reveals 19% higher bearing strength using a symmetric double shear test configuration. The eccentricity effect is more pronounced under compressive loading. Even the first laminate shows 20% difference in bearing strength.

### 1.5.3.3 Effect of W/D Ratio

Collings [1-30], Kretsis and Matthews [1-31] as well as Ramkumar and Tossavainen [1-25] showed that joint strength can be improved significantly by an increase in the W/D ratio (Plate Width/Hole Diameter). Kretsis and Matthews further pointed out that the failure mode changes from tension to bearing at W/D ratio equal to about 3.2 for GI/Ep [0/ $\pm 45^\circ$ ]<sub>2S</sub> and about 6 for GI/Ep [ $\pm 45^\circ$ ]<sub>3S</sub>. Figure 1-12. Collings showed that the change of failure mode occurs within the same range of W/D ratios for Gr/Ep. Matthews et al. [1-16] showed that the failure modes change (tension to bearing) at W/D = 3 for all cross-ply laminates made of all-carbon, all-glass and glass/carbon hybrid reinforced XD-927 epoxy systems. Ramkumar and Tossavainen showed that the bearing strength of a laminate remains relatively unchanged for W/D > 6. When W/D ≤ 4 the failure mode is net section failure across the hole. For W/D > 4 the failure mode is primary shear-



**Figure 1-12. Effect of W/D ratio on the bearing strength of GI/913 laminates.**  
D=6.35 mm (0.25"), t=3 mm (0.12"), clamping pressure=12 MPa.

out if the e/D is not large enough to create a bearing failure. All these results seem to suggest that the W/D value for the mode changeover point is larger for a matrix dominated laminate than that for a fiber dominated laminate.

#### 1.5.3.4 Effect of e/D Ratio

The work of Collings [1-29], Kretsis and Matthews [1-31] and Ramkumar and Tossavainen [1-25] all showed that the failure mode of Gl/Ep (former two Ref.) and Gr/Ep (latter Ref.) laminates changes from shear to bearing by increasing the e/D ratio (end distance/hole diameter) to some critical value. Increasing the e/D ratio also improves the joint strengths of the laminates. Kretsis and Matthews showed that the change of failure mode took place at e/D equal to 3 for Gl/Ep  $[\pm 45]_3S$  laminate and about 4.5 for Gl/Ep  $[0/90]_3S$ , Figure 1-13. Thus, the value of e/D for the change of failure mode is highly dependent on the laminate layup. Apparently, the first layup is more shear resistant than the second one. The value of e/D for the change of failure mode seems to change only slightly for different material systems, Figure 1-14 [1-31]. Moreover, the variation of the bearing strength versus the e/D ratio is more gradual for Gl/Ep than for Gr/Ep laminates.

#### 1.5.3.5 Effect of D/t Ratio

Kretsis and Matthews [1-31] have tested the bearing strength of Gl/Ep  $[0/\pm 45]_{2S}$  laminates with various hole diameters under the restraint condition of a finger-tight bolt. They concluded that bearing strength decreases significantly as D/t ratio (hole diameter/plate thickness) increases, Figure 1-15. The reason is that a large D/t ratio tends to cause out-of-plane buckling in the laminates. Figure 1-15 and the hybrid data [1-16] both show that the bearing strength has a linear relationship with D/t ratios between 1 and 3. For  $D/t > 3$ , the slope increases creating a nonlinear relationship. Oleesky and Mohr [1-20] suggested that full bearing strength is less likely to be developed if  $D/t > 1$ . Other researchers [1-12] show that the bearing strength is independent of the D/t ratio when sufficient lateral constraint is applied on the bolts.

#### 1.5.3.6 Effect of Stacking Sequence

The experimental results of Quinn and Matthews [1-33] and Smith and Pascoe [1-34] suggest that stacking sequence has significant effect on pin-bearing strength of Gl/Ep laminates [1-33] but has little effect for Gr/Ep laminates [1-34]. However, it must be noted that the  $[90/\pm 45/0]_S$  layup had the highest bearing

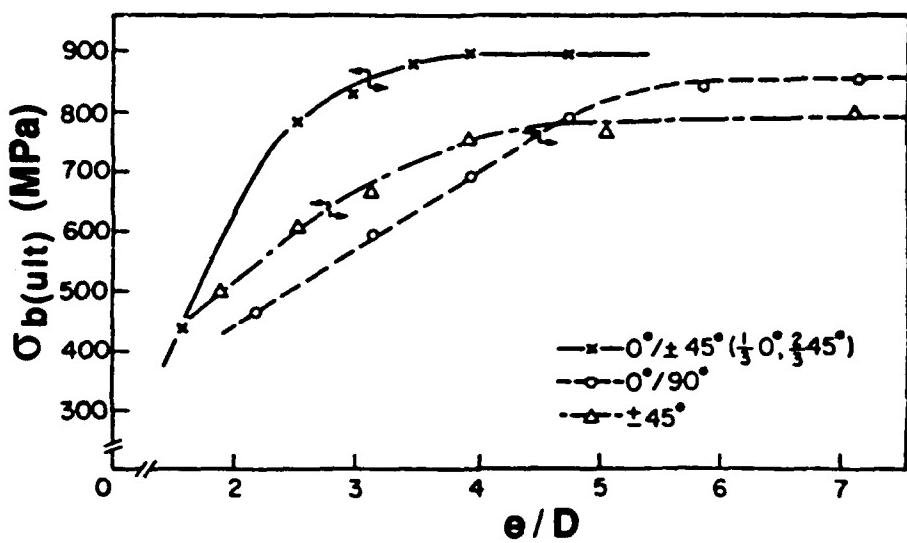


Figure 1-13. Effect of e/D ratio on the bearing strength of GI/913 laminates.  
 $D=6.35 \text{ mm (0.25")}$ ,  $t=3 \text{ mm (0.12")}$ , clamping pressure=12 MPa.

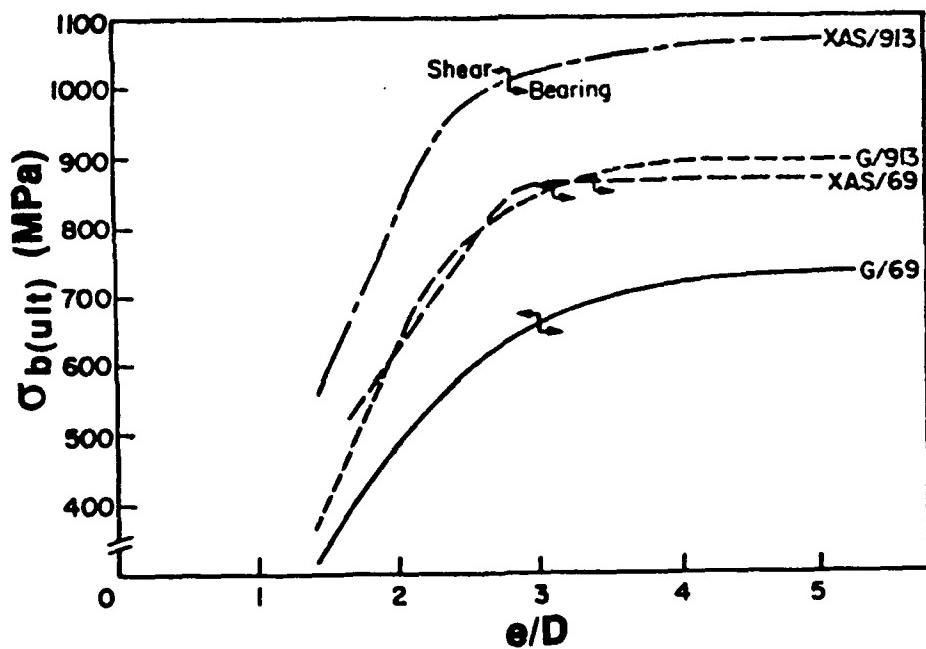


Figure 1-14. Effect of e/D ratio on the bearing strength of  $[0/\pm45]_{2S}$  laminates.  
 $D=6.35 \text{ mm (0.25")}$ ,  $t=3 \text{ mm (0.12")}$ , clamping pressure=12 MPa.

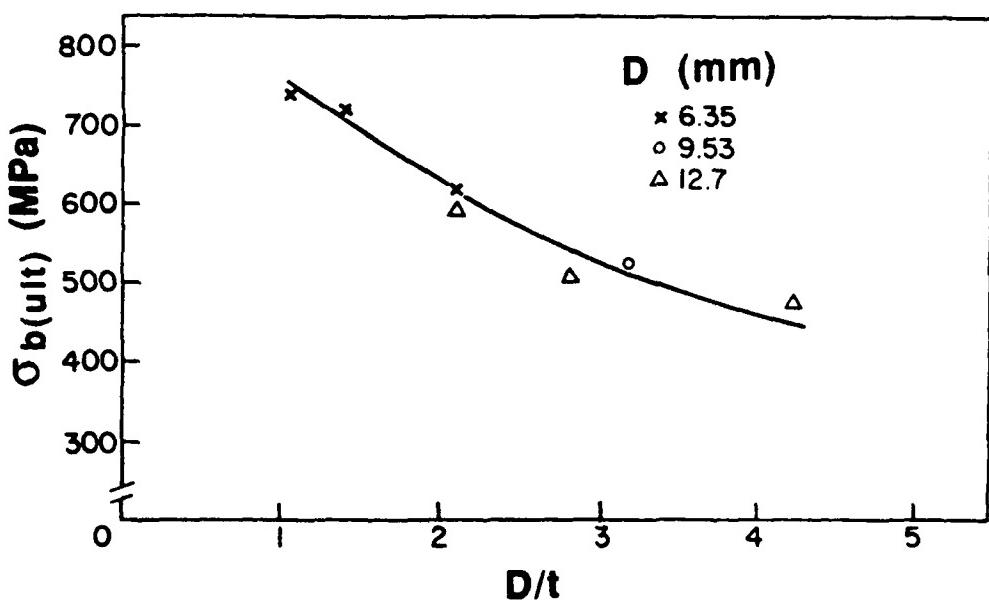
strength for the Gl/Ep material system [1-33], and this layup was not tested for the Gr/Ep system [1-34]. The former authors [1-33] showed that placing the 90° layer at or near the laminate surface increases the bearing strength of Gl/Ep laminates, Figure 1-16. According to the data in Ref. [1-34], the stacking sequence effect on the bearing strength of Gr/Ep laminates is eliminated as the clamp-up torque is increased to 20 in-lb. The value of clamping pressure that creates the same effect for Gl/Ep laminates is unknown currently. It has been shown that the stacking sequence changes the failure mode and the failure sequence due to the difference in stress distribution. Some of this phenomenon can be qualitatively explained by the interlaminar normal stress [1-34].

Grouping together plies with the same orientation can cause a reduction in the bearing strength. The study by Ramkumar and Tossavainen [1-25] concluded that the reduction in bearing strength is approximately 7%, 10% and 5%, respectively, for three different stacking sequences of Gr/Ep (AS1/3501-6)  $[(45/0/-45/0)_2/0/90]_S$ ,  $[45/0/-45/0_3/90/0_3]_S$  and  $[45/0/-45/0/45/90/-45/0/45/-45]_S$  laminates.

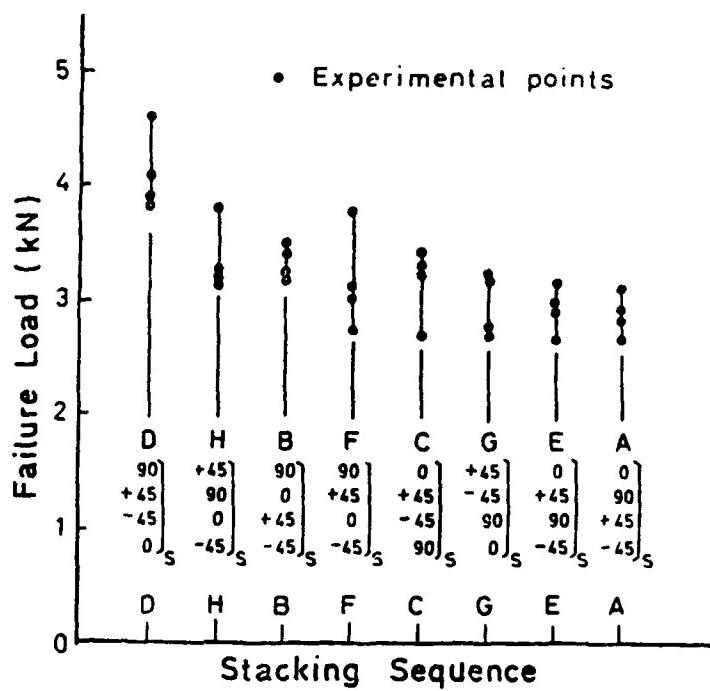
#### 1.5.3.7 Effect of Multiple-Bolted Joints

In practice, multiple-bolted joints are of great importance. Within a multiple-bolted joint, fastener holes normally are subjected to the combined effects of bearing loads and bypass loads. One must be very careful in using single-bolted joint data to design structures with multiple-bolted data. Abundant data in the literature have shown that single-bolted joint data are not directly translatable into multiple-bolted data. This is understandable because of the stress interaction between the bolt holes. The stress field of each bolt hole is influenced by the surrounding bolt holes, which cause a weakening effect. This interaction becomes increasingly significant as the hole distance is reduced.

Multiple-bolted joints can change the failure mode of a laminate as compared to a single-bolted joint. Pyner and Matthews [1-35] have shown that a Gl/Ep  $[-45/0]_{2S}$  laminate with a single-bolted joint failed in tension and shearout modes under tension loading. It changed to a purely tension mode for a joint consisting of four bolts in a line. This phenomenon can be explained by the result of the stress analysis performed by Ramkumar et al. [1-36]. The loads are not uniformly distributed among the four bolts. Instead, the distribution is quite different from one bolt to another. The ratios for five bolts in a line are 0.164:0.124:0.161:0.207:0.345 as shown in Figure 1-17. Ramkumar and Tossavainen [1-37] and Garbo et al. [1-38]



**Figure 1-15.** Effect of D/t ratio on the bearing strength of GI/69 [0±45]<sub>2s</sub> laminates. t = 3, 4.5 or 6 mm (0.12, 0.18 and 0.24 in.), finger-tight bolt.



**Figure 1-16.** Effect of stacking sequence on failure load of GI/Ep laminates.

have conducted a significant number of static tests on multiple-bolted joints using Gr/Ep laminates. Godwin et al. [1-39] and Chang et al. [1-40] have also conducted static tests on multiple-bolted joints using Gr/Ep and Gl/Pe laminates, respectively.

#### 1.5.3.8 Effect of Staggered Rows of Fasteners

Godwin et al. [1-39] demonstrated that no substantial improvement in bearing strength was gained by using staggered rows of fasteners. However, the use of

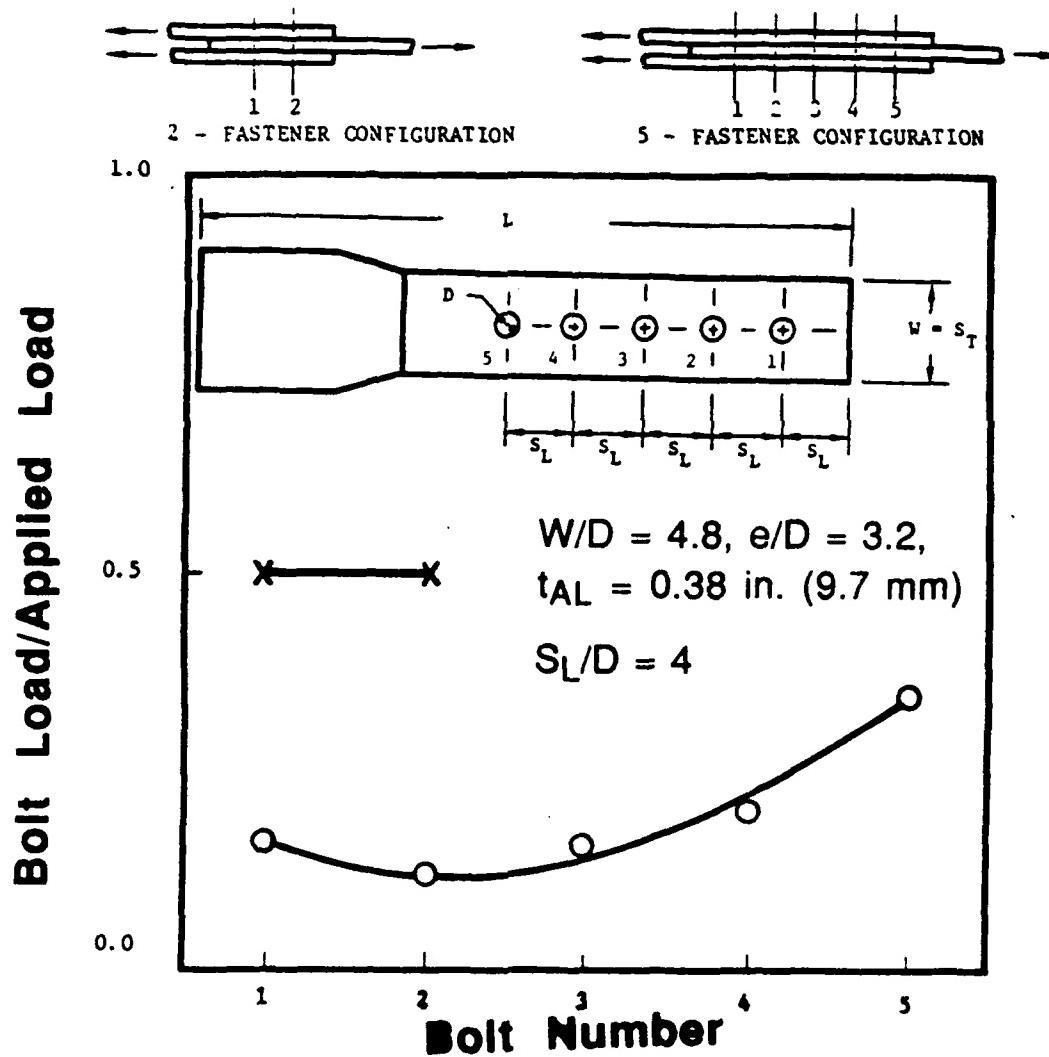


Figure 1-17. Fastener load distribution in AS1/3501-6 50/40/10 (% of 0,  $\pm 45$  and  $90^\circ$  plies) laminates (Double-lap joint, bolt diameter=5/16 in., protruding head steel bolt torqued to 100 in-lb, room temperature dry condition).

staggered rows of fasteners creates a larger damaged area as compared to a single row of fasteners. This suggests that the design of a staggered row of fasteners can absorb more energy than a single row of fasteners does. In practice, however, a rectangular fastener pattern is more commonly used than staggered rows.

#### **1.5.4 Effect of Loading Parameters**

Loading parameters include static tension, static compression, static bearing-bypass loading and fatigue loading. All the testing results mentioned above were conducted under static tension or static compression loading conditions. The bearing-bypass loading and fatigue loading will be discussed in the following.

##### **1.5.4.1 Effect of Bearing and Bypass Loads**

In many practical cases, fastener holes are subjected to the combined effects of bearing loads and loads that bypass the hole to be reacted elsewhere in the joint. The portion that bypasses the hole is defined as bypass load. Any bearing-bypass testing requires an apparatus that can apply bearing and bypass loadings simultaneously. Very little experimental data are available in this area.

Three approaches have been reported in the literature for bearing-bypass testing in composite laminates. The first approach uses levers and linkages to divide the applied load into two proportional parts [1-41]. The second approach uses a "scissor" mechanism to apply a bearing load between two holes in the test specimen [1-42]. This bearing load is held constant while the bypass load is varied. The third approach uses two servo-control systems. One controls the bearing load while the other controls the bypass load [1-43]. Crews and Naik [1-44] developed a testing apparatus similar to Concannon's [1-43] but simpler in design. They used Gr/Ep (T300/5208) [0/45/90/-45]<sub>2S</sub> laminates to show that clearance fit created a nonlinear relationship between the bearing and the contact angle. Naik and Crews [1-45] have reported the fracture strength of Gr/Ep T300/5208 laminates under several combinations of bearing-bypass load ratios ( $\pm 0$ ,  $\pm 1$ ,  $\pm 3$  and  $\pm \infty$ ). They found that bearing and bypass strength in the tension quadrant form a linear interaction, Figure 1-18, which agrees with the observation by Smith [1-17].

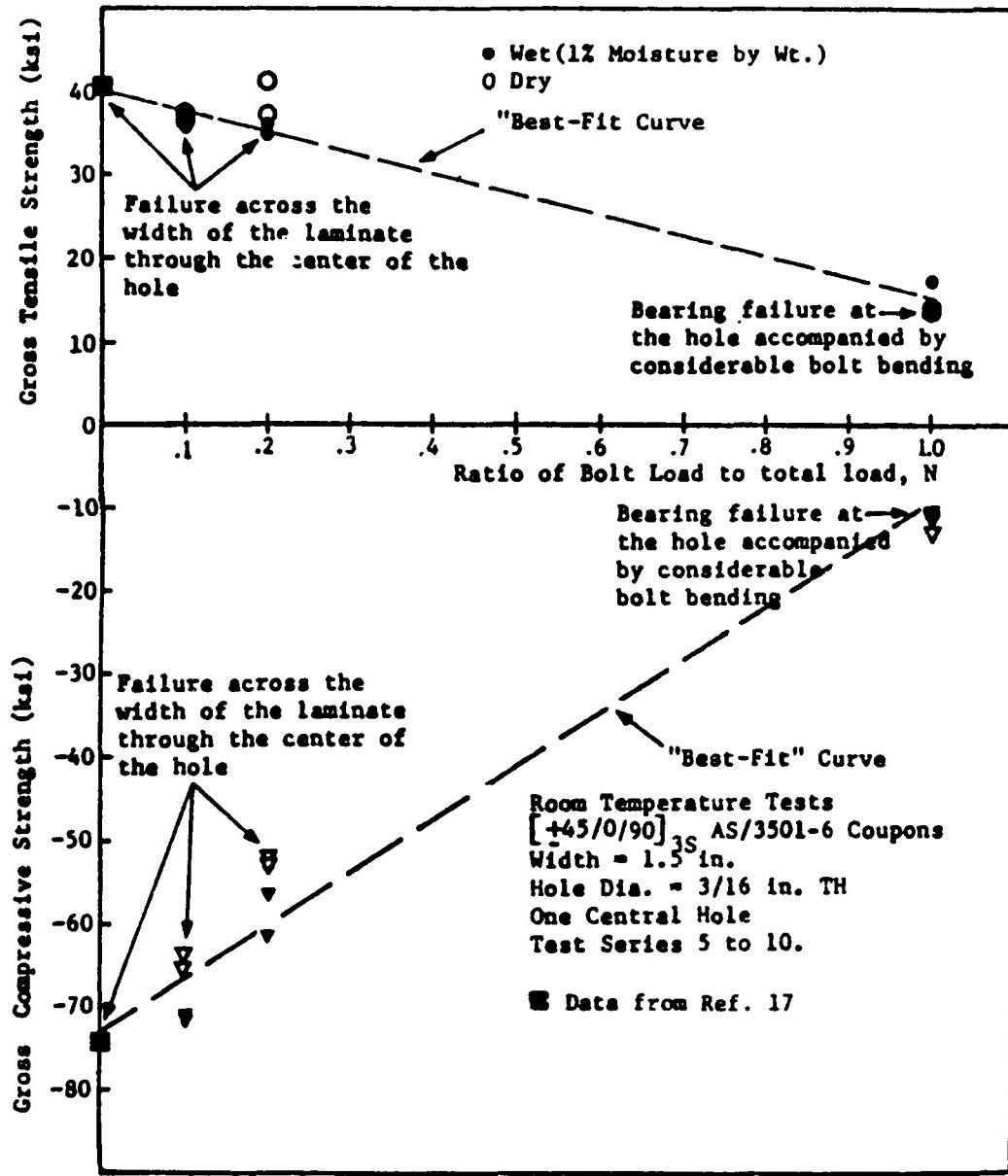
Ramkumar [1-41] showed that the gross tensile and gross compressive strengths are linearly proportional to N (the ratio of the bolt load to the total applied load) for a AS1/3501-6 [ $\pm 45/0/90$ ]<sub>3s</sub> laminate, Figure 1-19. This relationship is interesting because it involves a change of failure mode from net section to bearing. Additional study is needed for an in-depth explanation of this kind of relationship.

#### 1.5.4.2 Effect of Fatigue Loading

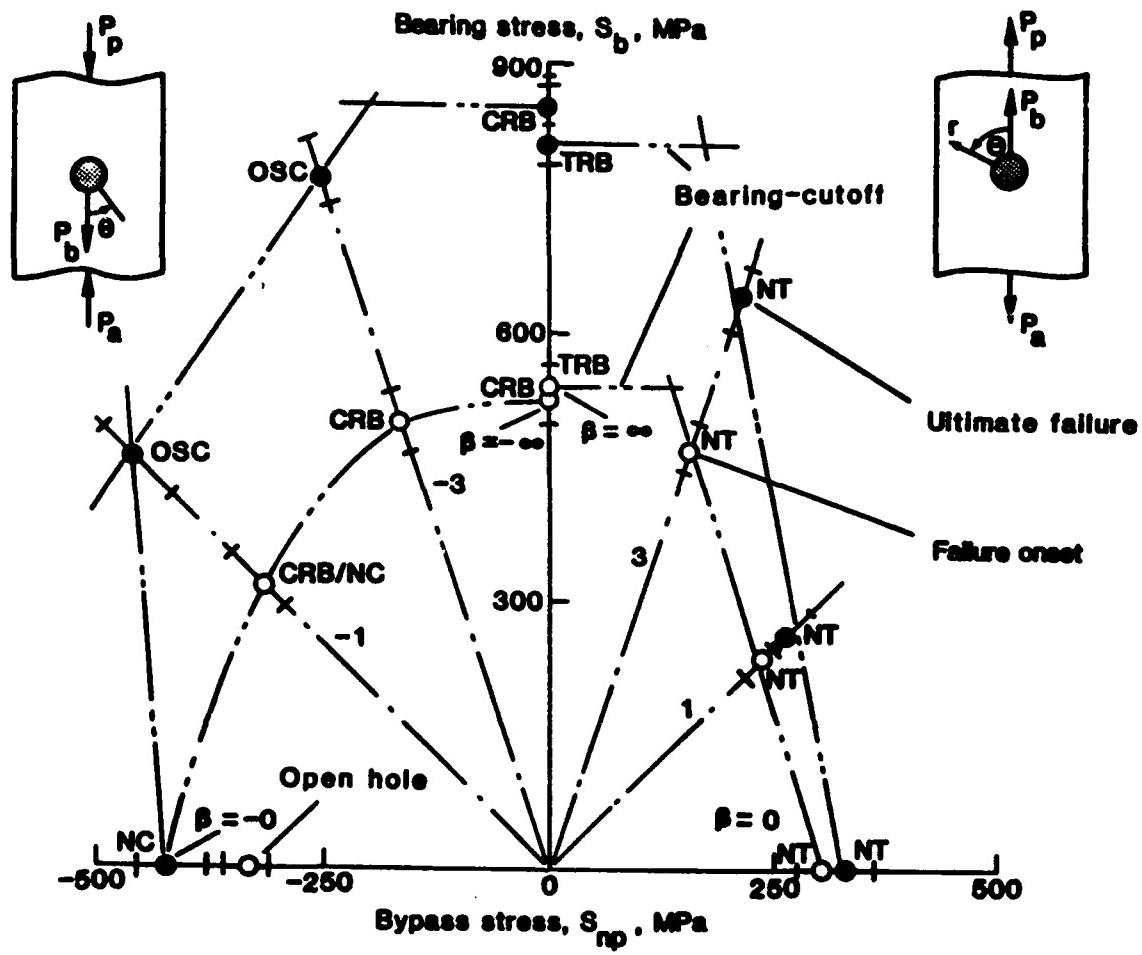
Very few papers have been published in the area of fatigue of bolted joints in composite laminates. Crews [1-46] has studied T300/5208 [0/45/90/-45]<sub>2s</sub> laminates under bolt bearing loads for a range of bolt clampup torque and three environmental conditions including water. His result showed that high clampup torque improved both the static and fatigue limit by about 100% compared to a pin-bearing case. He also found that tests in water degraded static bearing strength slightly, but reduced the fatigue limit about 40% below that obtained in air.

Ramkumar [1-25] shows that for tension-tension fatigue loading, no fatigue failures were induced (for a million cycles) in AS1/3501-6 [(45/0/-45/0)<sub>2</sub>/0/90]<sub>s</sub> laminates when the maximum cyclic bearing stresses are below 90% of the static bearing strength. For compressive-tension-compression fatigue, the laminate does not suffer any fatigue failure if the maximum cyclic bearing stresses are below 85% of the static bearing strength. For tension-compression fatigue, fatigue failures will occur if the maximum cyclic bearing stress value is above 35% of the static bearing strength.

From the test results of Ramkumar and Tossavainen [1-25], it is quite important to note that when 100° tension flush-head steel fasteners were used, four out of nine tests resulted in fastener failures. When titanium fasteners were used instead of steel, fastener failures occurred in every case. As opposed to static loading tests, this result reveals that graphite/epoxy composite is much more fatigue resistant than metals.



**Figure 1-18. The interaction of the bearing-bypass strength of Gr/Ep T300/5208 [0/45/90/-45]<sub>2S</sub> laminates.**



where

- NT: net-section tension,
- TRB: tension-reacted bearing,
- CRB: compression reacted bearing,
- NC: net-section compression,
- OSC: offset-compression.

**Figure 1-19. Gross tensile strength versus bolt load/total load for Gr/Ep AS1/3501-6 [±45/0/90]<sub>3S</sub> laminates.**

### 1.5.5 Environmental Parameters

In 1977, Wilkins [1-47] tested and reported that pin-bearing strengths of many Gr/Ep T300/5208 laminates (especially those containing  $\pm 45^\circ$  and  $90^\circ$  layers) were not affected by moisture content up to 1.48% at room temperature and at elevated temperatures up to 200° F. Those laminates that contain  $0^\circ$  layers are most affected, as shown in Figure 1-20. For instance, the pin-bearing strength of Gr/Ep 50/50/0 (% of 0,  $\pm 45$  and  $90^\circ$  layers) laminates for the 75° F dry condition is 122.7 ksi. It decreases to 105.1 ksi (14% decrease) after it was soaked 142 days at 180° F and 98% relative humidity (1.48% weight gain). The bearing strength was further reduced to 100.3 ksi (18% decrease) when it was subjected to 42 heat spikes at 300°F. Compared with unnotched laminates, Wilkins found that the reduction in fracture strength due to environmental effects was more significant in the case of bolted joints.

Ramkumar and Tossavainen [1-25] studied the Gr/Ep AS1/3501-6 [(45/0/-45/0)<sub>2</sub>/0/90]<sub>S</sub> (50/40/10), [45/0/-45/0<sub>3</sub>/90/0<sub>3</sub>]<sub>S</sub> (70/20/10) and [45/0/-45/0/45/90/-45/0/-45/-45]<sub>S</sub> (30/60/10) laminates. They showed that the bearing strengths of these

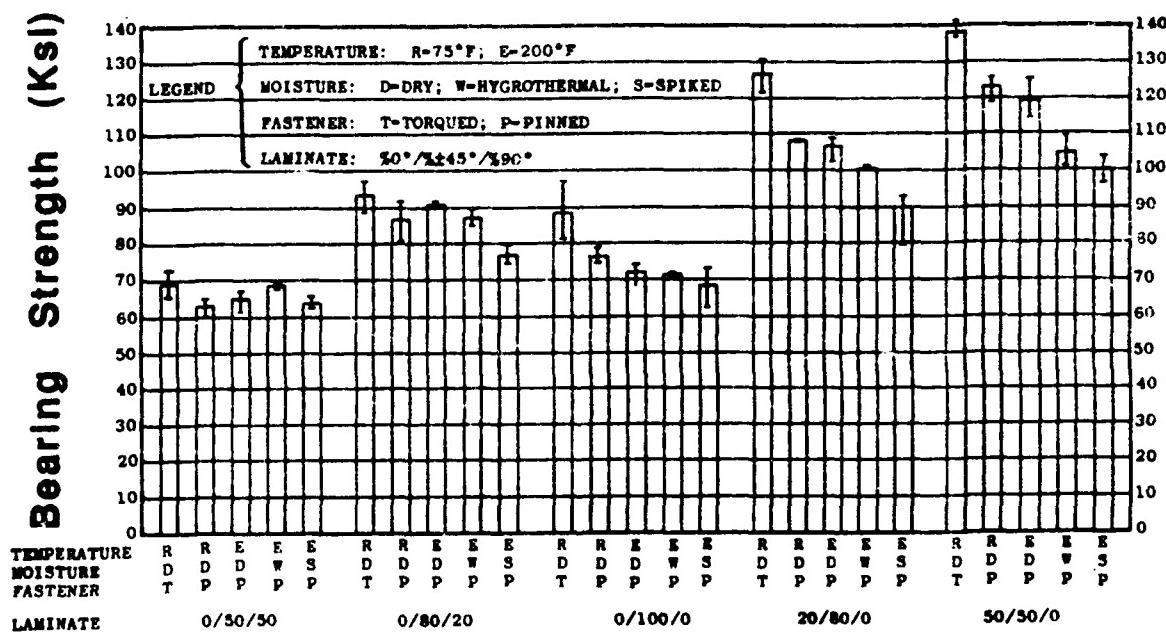


Figure 1-20. Environmental effects on bearing strength of Gr/Ep T300/5208 laminates.

laminates were decreased by 8, 12 and 8%, respectively, at 218°F and 1.0% moisture content as compared to room temperature dry conditions. Garbo and Ogonowski [1-26] compared the bearing strengths at room temperature-dry and 250°F-0.9% moisture content conditions. They reported a reduction of 11, 22, 16 and 12% for the T300/5208 30/60/10 and 50/40/10 laminates as well as AS1/3501-6 50/40/10 laminate, respectively.

These results show that hot-wet environmental conditions can cause a reduction in bearing strength up to 16% in most cases. It can increase to 20% or more with thermal spiking.

As opposed to all the results mentioned above, Kim and Whitney [1-48] reported a tremendous reduction in bearing strength of Gr/Ep T300/5208 laminates due to moisture and elevated temperature. They tested  $[0_2/\pm45]_{2S}$ ,  $[90_2/\pm45]_{2S}$  and  $[0/90/\pm45]_{2S}$  laminate layups and found that room temperature wet (1.5% moisture content by weight) bearing strengths decreased by 11, 10 and 13%, respectively, compared with the room temperature-dry baseline condition. At 260°F and the same wet condition, the bearing strengths decreased by 38, 39 and 40%, respectively. No other investigators have reported this much of strength reduction.

### 1.5.6 Human and Machining Parameters

Technicians and engineers can make mistakes or imperfections during specimens preparation and bolt installation. Similarly, machining tools do not always produce good quality and dimensional accuracy needed, especially if alignment and maintenance are not maintained properly on a timely and regular basis. Extremely limited studies have been performed on the effects of these human and machining parameters on bolted joints. Some of these issues were addressed by Garbo and Ogonowski [1-26] in 1981. For the sake of convenience, the following symbols are denoted:

RTD = Room temperature dry condition;

ETW = Elevated temperature (250°F) wet (0.86% moisture content) condition.

***Out-of-Round Holes.*** The testing results in Ref. [1-26] show that a bolted hole with a 0.004 in. straight portion in the middle (see Figure 1-21) causes 1.3% decrease and 4.3% increase in bearing strength of AS1/3501-6 30/60/10 and 50/40/10 respectively, at RTD.

**Delaminations.** Drilling a hole in composite laminates without a backing material and/or at too fast a feeding speed can cause delamination and fiber breakout on the exit side of the hole. Garbo and Ogonowski [1-26] reported reduction in bearing strengths of 2.0 and 7.3% at RTD with moderate and severe delaminations, respectively, in 50/40/10 laminates. At ETW, the loss in bearing strength with these type delaminations was 3.7 and 8.7%, respectively.

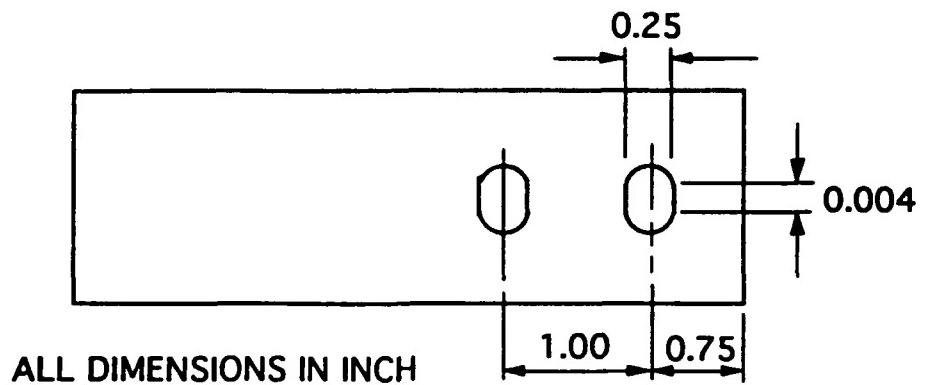
**Porosity.** Porosity can easily be formed during the processing of composite laminates. As shown in reference [1-26], moderate and severe porosity can cause reduction in bearing strengths for 50/40/10 laminates by 8 and 12%, respectively, at room temperature and after exposure to freeze-thaw cycles. The reductions increased to 13 and 30% when the laminates were tested at ETW condition.

**Improper Fastener Seating.** This happens when the countersink tool wobbles and produces a countersunk angle that does not match the angle on the head of the fastener. The result is that the bolt head sits below or protrudes above the laminate surface. Extreme cases were considered with 80 and 100% of the countersink head hanging free (only 20% of the laminate thickness or a circumferential line (knife edge) was in contact with the bolt). The bearing strengths were decreased by 20 and 53%, respectively, for 50/40/10 laminates at RTD condition.

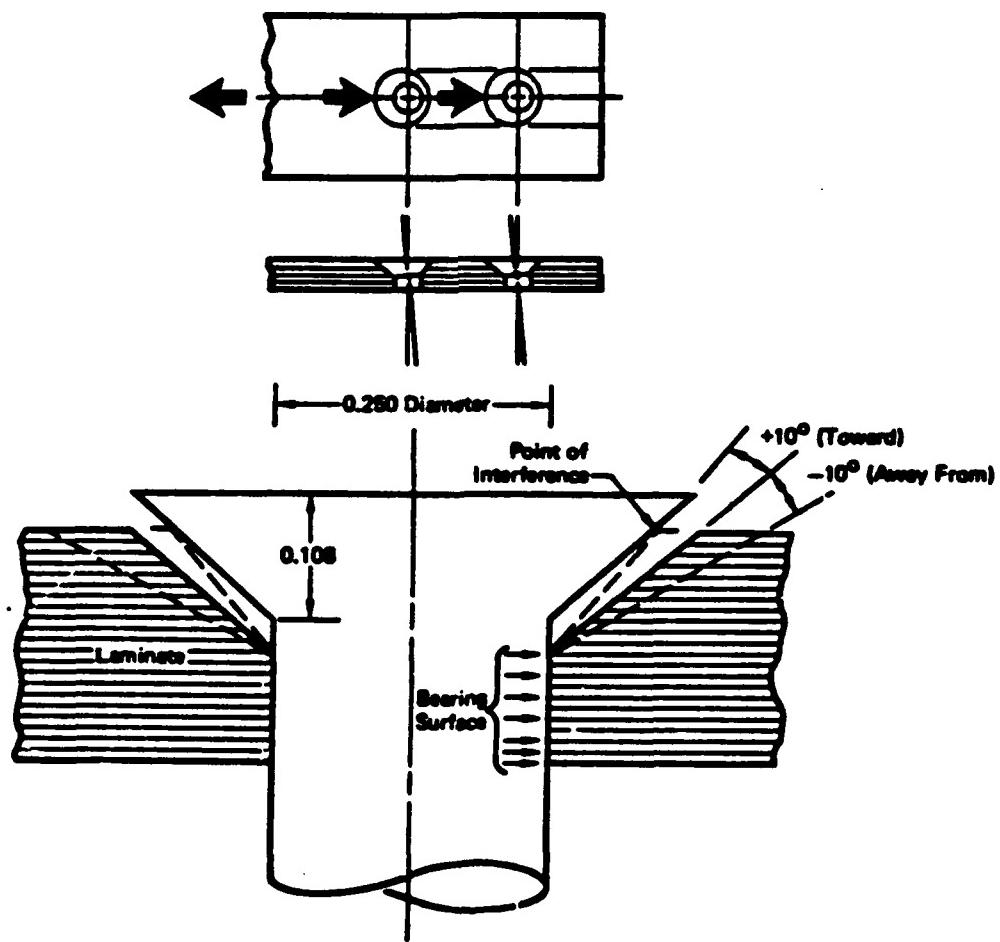
**Tilted Countersink.** This problem is created if the hole drilling direction is not parallel to the thickness direction of the laminate, as shown in Figure 1-21. Both toward and away from bearing conditions were studied. Here, "toward" and "away" mean that either smaller and or countersink angles were formed in the laminate. The reduction in bearing strengths of the 50/40/10 laminates were 18 and 14% at RTD and ETW conditions, respectively, in the "toward" case. For the "away" case, the changes in bearing strengths were +1% (increase) and -13% (decrease), respectively, at RTD and ETW conditions, respectively.

## 1.6 LOAD-DEFLECTION RESPONSE

The load-deflection relationships have been measured by using applied load versus machine crosshead displacement or versus specimen deflection as recorded with extensometers. Results obtained by both of these techniques are discussed in the following sections.



(a) out-of-round hole

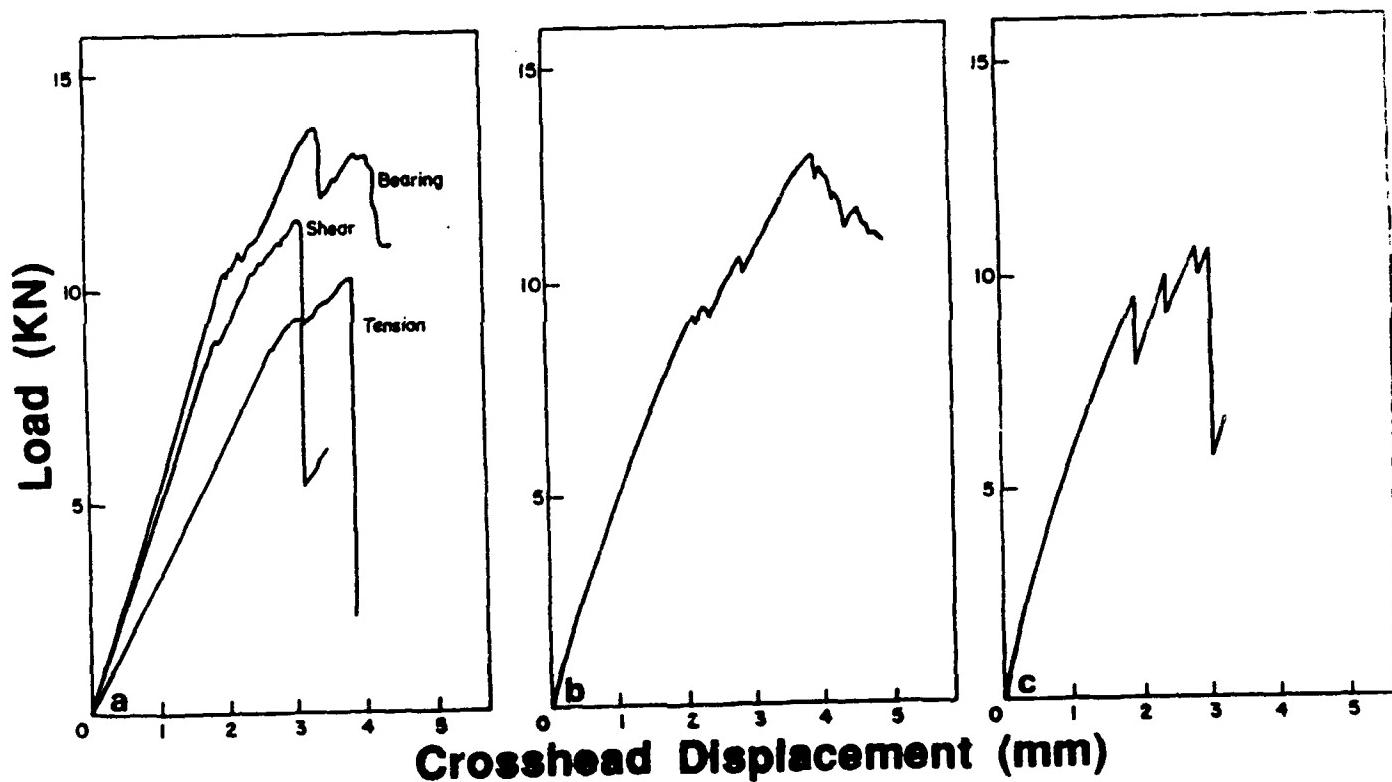


(b) tilted countersink

**Figure 1-21.** Schematic diagrams of (a) out-of-round hole and (b) tilted countersink and specimen configuration.

### 1.6.1 Load-Crosshead Displacement

Kretsis and Matthews [1-31] tested the applied load versus the crosshead displacement of some GI/69 (glass/epoxy) laminates with single-bolted joints. Their results showed that tension and shear failure modes are much more catastrophic than the bearing failure mode, Figure 1-22. These three failure modes were generated using three different specimen geometries. One must be very careful in the examination of these load-displacement relationships. Although the bearing curve has highest failure load among the three modes considered, the



**Figure 1-22. Load-displacement curves for GI/69 laminates with D=6.35 mm (0.25"), t=3 mm (0.12") and clamping pressure=12 MPa. (a) [0/±45]2s, bearing: W=40 mm, e=30 mm; tension: W=17 mm, e=25 mm; shear: W=40 mm, e=16 mm; (b) ±45 symmetric, bearing: W=60 mm; (c) 0/90 symmetric, bearing: W=45 mm, e=40 mm.**

tension failure produce the highest gross fracture strength.

### 1.6.2 Load-Extensometer Measurements

Joint stiffness of a specimen with bolted joints is normally measured using extensometers. It is not a material property of the fastener or the laminate, rather, it is a structural property that depends on the fastener type and material, the laminate configuration and the joint type. Therefore, when the value of joint stiffness is reported, the joint configuration and the length of the extensometer used as well as its location must be specified. Most investigators did not measure this property. Only a limited number of references can be found in the literature. They are discussed in the following.

Ramkumar and Tossavainen [1-25] studied the joint stiffness of Gr/Ep (AS1/3501-6) laminates using 87.6 mm (3.45 in) long extensometers. It can be seen from their pictures that the locations of the extensometers were at the two ends of the specimens. The load-deflection curve for solid pin fasteners is generally composed of three portions. The first portion (initial offset) represents the region where friction between the laminate and the aluminum coupons (this is created due to lateral constraint applied through fasteners) is overcome. Thus, a higher fastener torque normally produces a larger initial offset region. The second portion is linear and the third portion is nonlinear and unsmooth. Significant damage is accumulated in this portion of the loading history. The joint stiffness is normally measured from the second region of this load-deflection curve. Some of the representative results under tensile loading are illustrated in Figures 1-23 through 1-27. Figures 1-23 and 1-24 show the results for Gr/Ep [(45/0/-45/0)<sub>2</sub>/0/90]<sub>S</sub> (50/40/10) laminates. Figures 1-25 and 1-26 are for [45/0/-45/0<sub>3</sub>/90/0<sub>3</sub>]<sub>S</sub> (70/20/10) layups. Figure 1-27 illustrates test results for a [45/0/-45/0/45/90/-45/0/ $\pm$ 45]<sub>S</sub> (30/60/10) laminate. The compression results are illustrated in Figures 1-28 and 1-29 for [(45/0/-45/0)<sub>2</sub>/0/90]<sub>S</sub> (50/40/10) and [45/0/-45/0<sub>3</sub>/90/0<sub>3</sub>]<sub>S</sub> (70/20/10) laminates, respectively. The joint type (single or double lap), the fastener type (PH, CSK-T and CSK-S stand for protruded head, countersink with tension head and countersink with shear head, respectively) and the torque applied at the fastener are indicated at the upper left corner in all figures. The characteristics of these curves are similar regardless of the joint type and fastener type and material.

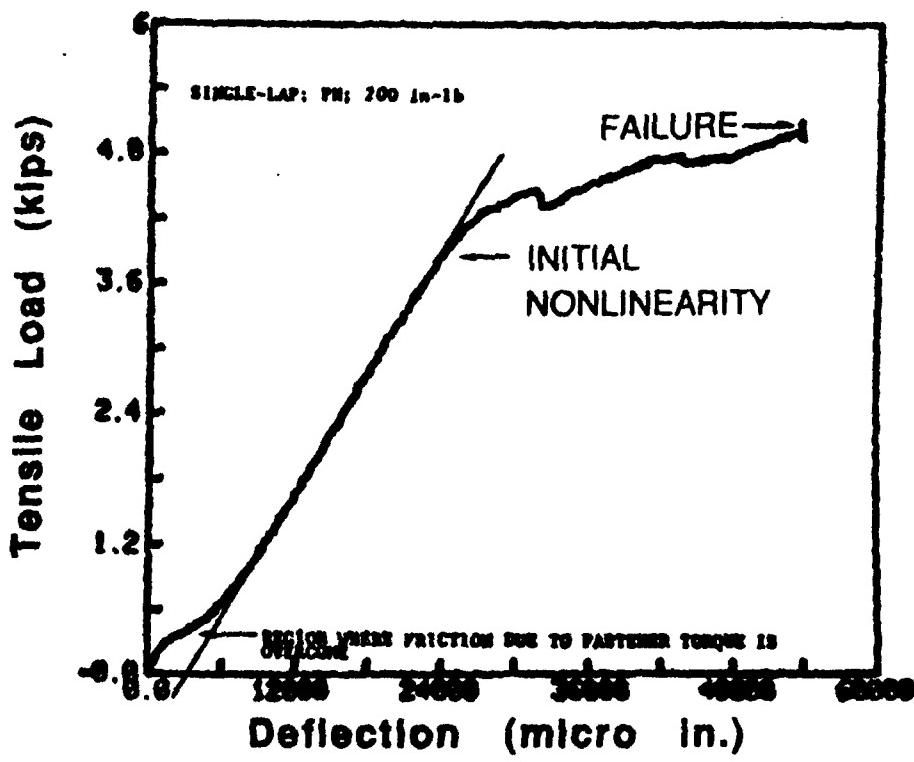
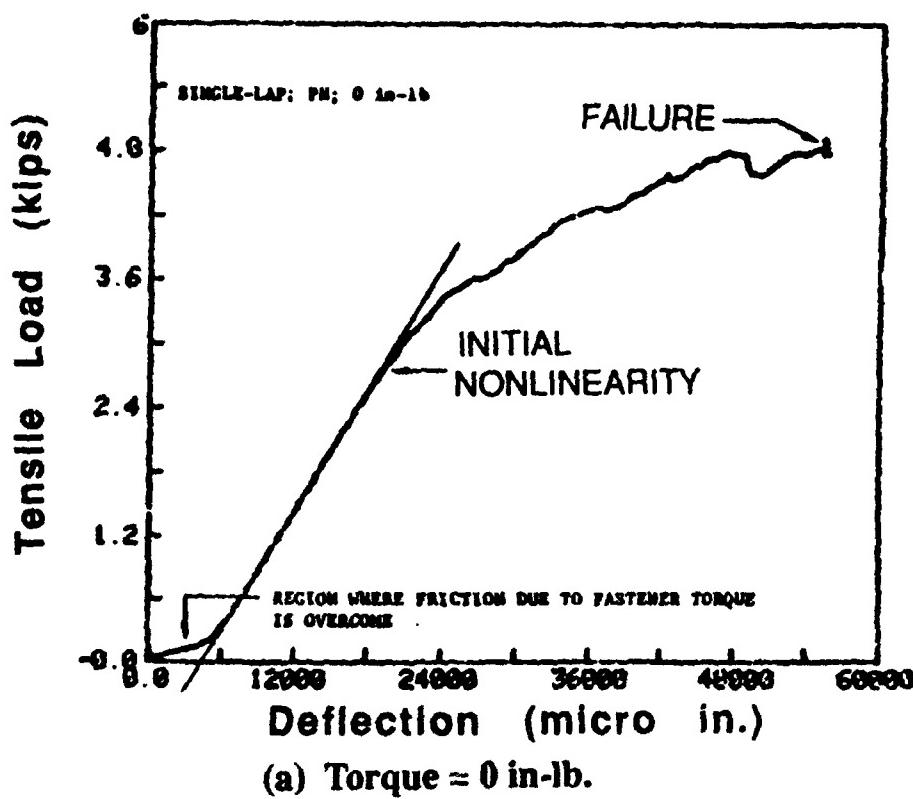


Figure 1-23. Load-deflection of Gr/Ep  $[(45/0/-45/0)_2/0/90]_S$  laminate with single lap-single joint and under tensile loading.

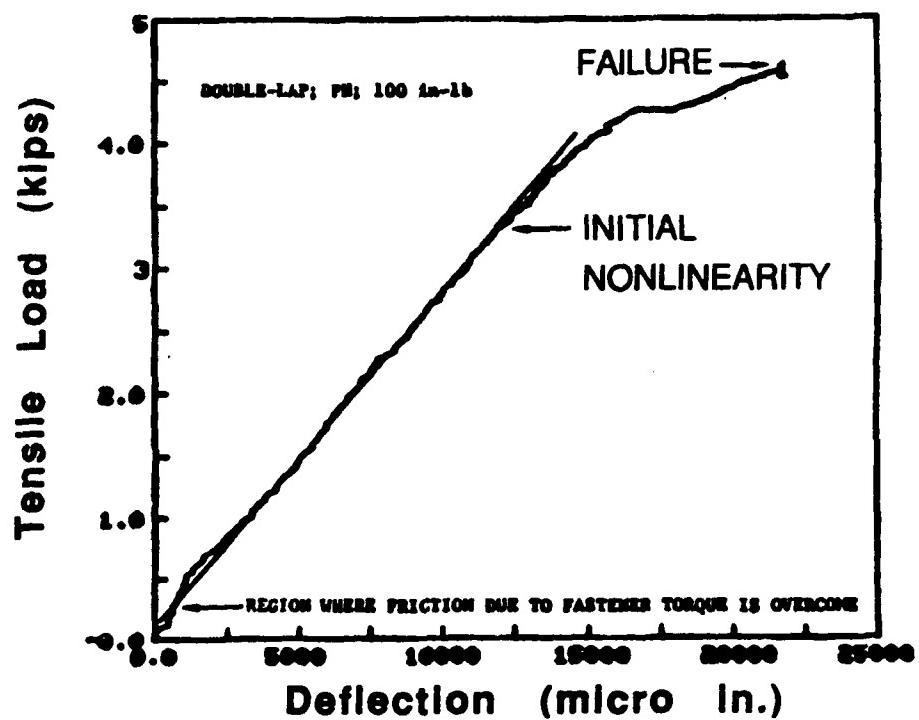
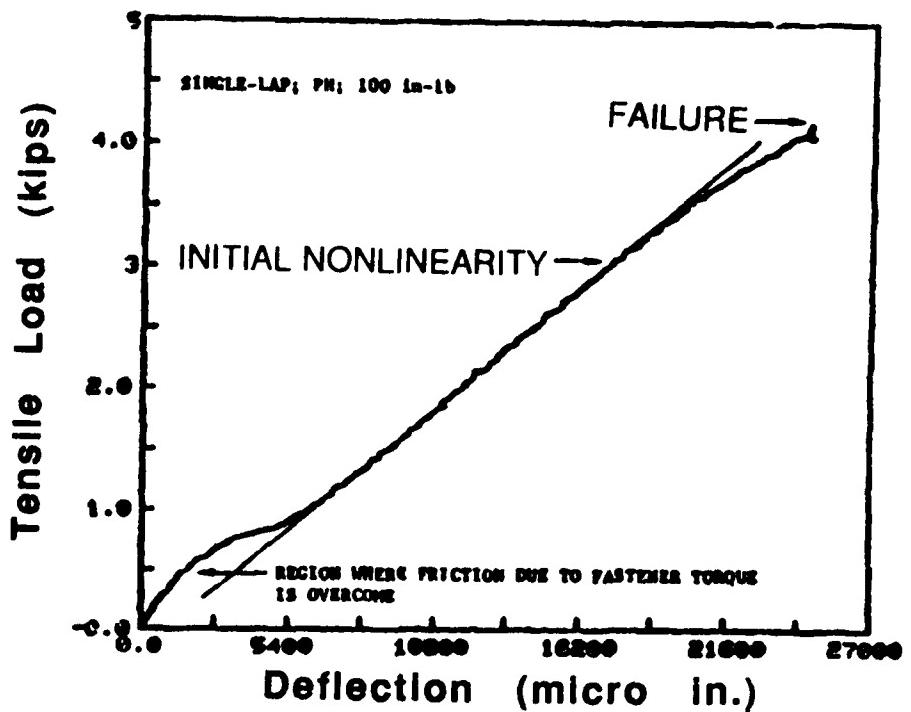
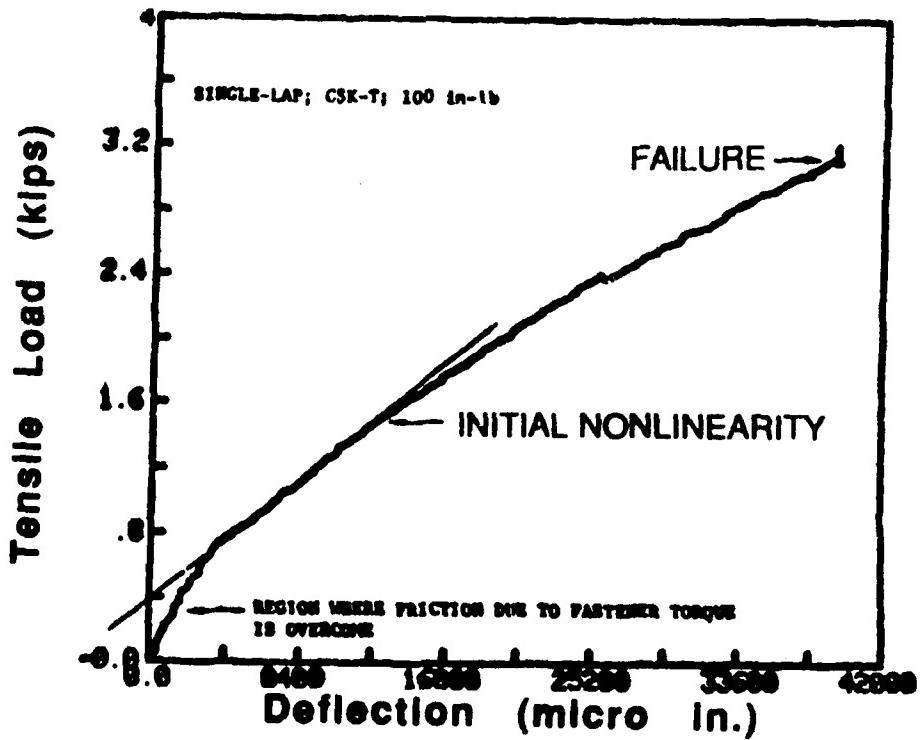


Figure 1-24. Load-deflection of Gr/Ep  $[(45/0/-45/0)_2/0/90]_S$  laminate with double lap-single joint and under tensile loading.

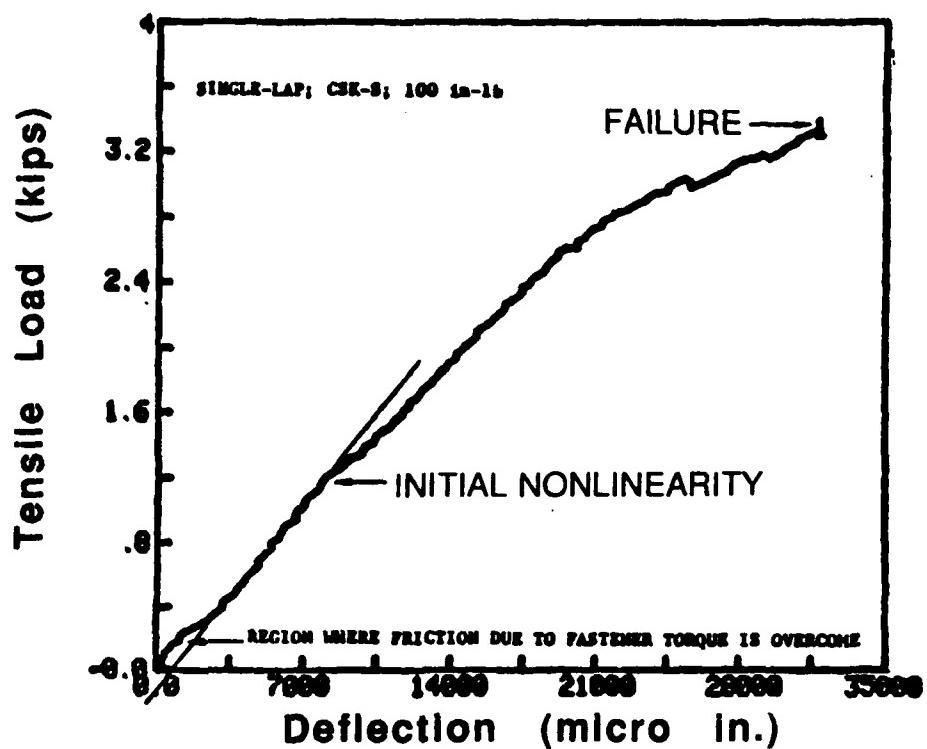


(a) Protruding head fastener.



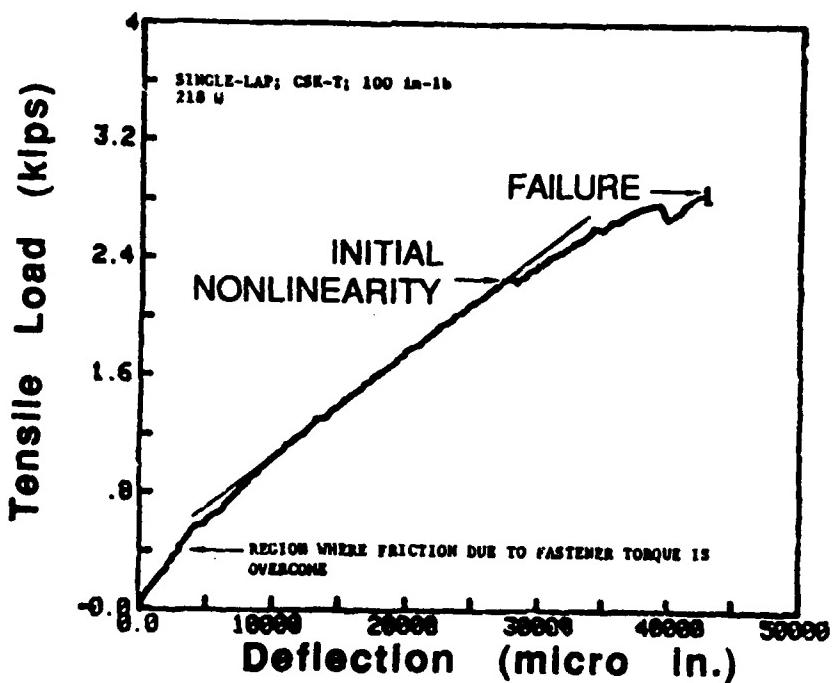
(b) Countersunk tension head fastener.

Figure 1-25 Load-deflection of Gr/Ep [45/0/-45/0<sub>3</sub>/90/0<sub>3</sub>]<sub>s</sub> laminate with single lap-single joint and under RTD, tensile loading.

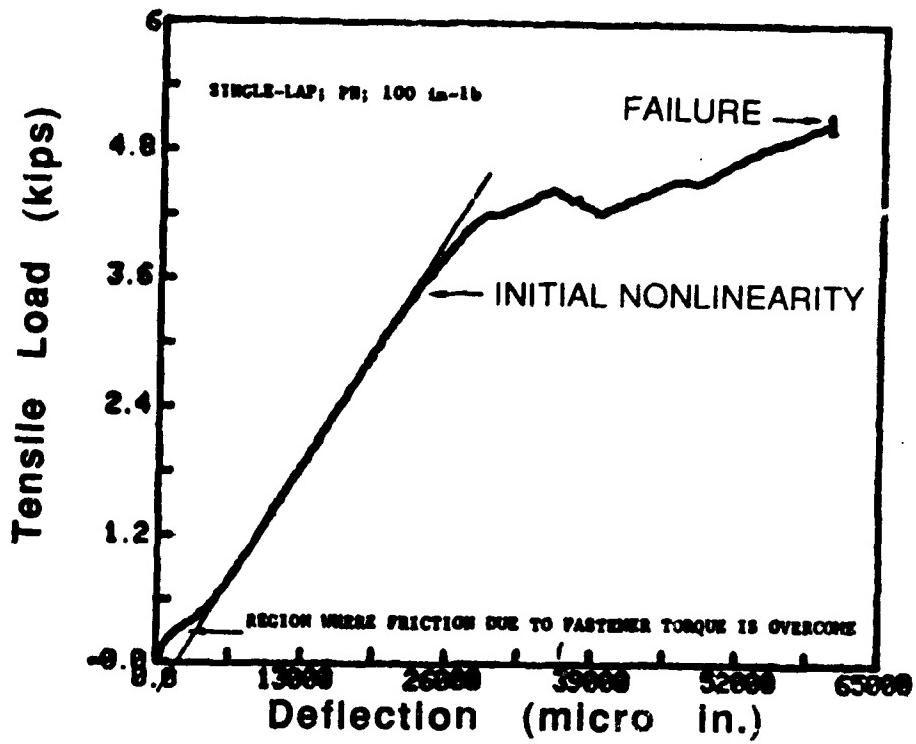


(c) Countersunk shear head fastener.

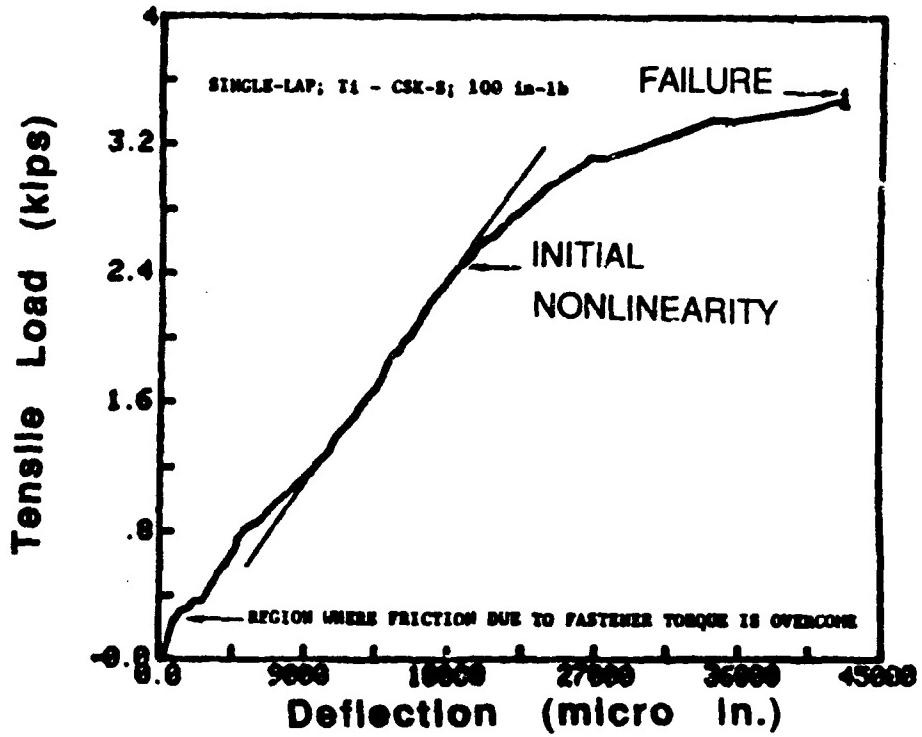
**Figure 1-25 (cont.).** Load-deflection of Gr/Ep [45/0/-45/0<sub>3</sub>/90/0<sub>3</sub>]<sub>s</sub> laminate with single lap-single joint and under RTD, tensile loading.



**Figure 1-26.** Load-deflection of Gr/Ep [45/0/-45/0<sub>3</sub>/90/0<sub>3</sub>]<sub>s</sub> laminate with single lap-single joint and under RTW, tensile loading.

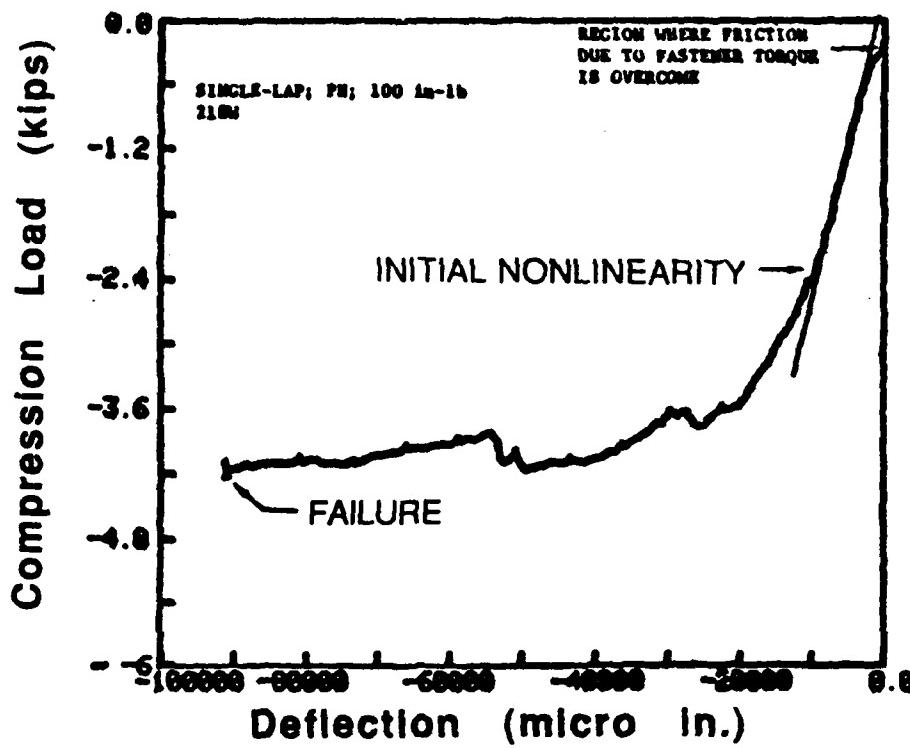


(a) Steel Protruding head fastener.

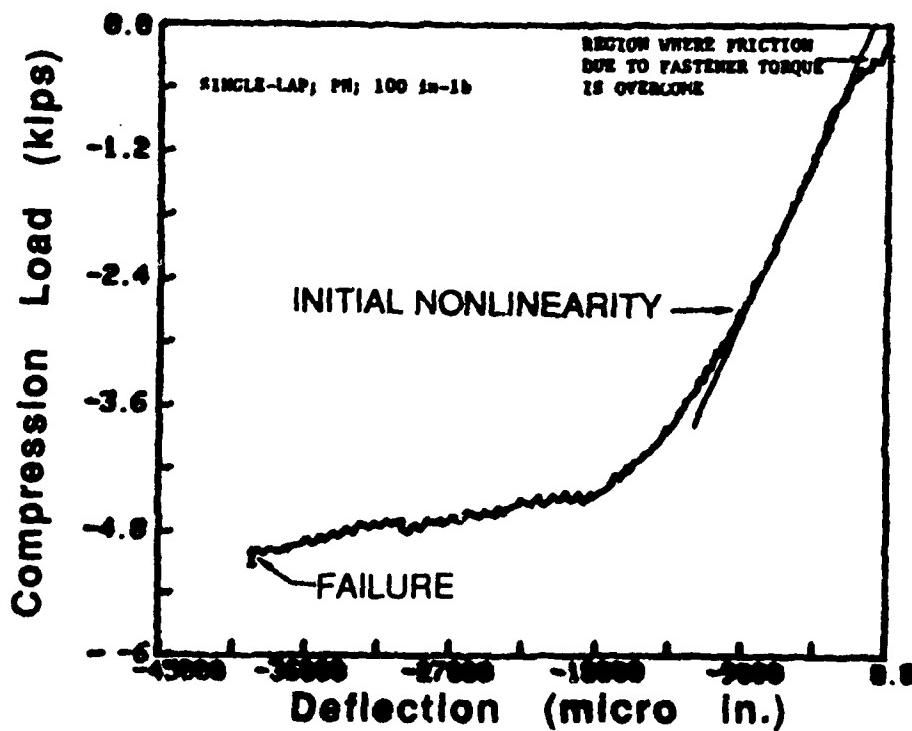


(b) Ti countersunk shear head fastener.

Figure 1-27. Load-deflection of Gr/Ep [45/0/-45/0/45/90/-45/0/ $\pm$ 45]<sub>S</sub> laminate with single lap-single joint and under RTD, tensile loading.



**Figure 1-28.** Load-deflection of Gr/Ep  $[(45/0/-45/0)2/0/90]_s$  laminate with single lap-single joint and under RTD, compressive loading.



**Figure 1-29.** Load-deflection of Gr/Ep  $[45/0/-45/03/90/03]_s$  laminate with single lap-single joint and under RTW, compressive loading.

## 1.7 DATABASE

Three computer programs have been written using the software called "Excel" (Version 2.2) in Macintosh computers. They are "Single J-Tension," "Bearing-Bypass" and "Multiple Joints" for laminated composites with single bolted-joints loaded in tension, bearing-bypass loading and multiple bolted-joints loaded in tension or compression, respectively. The contents of these programs are shown in the following:

A	B	C	D	E.....	...Z
1 Material	Percent of	Stacking	Plate	Plate....	Remarks
2 System	0/±45/90	Sequence	Width	Thickness	
3 Fiber/Resin	plies		W(in.)	t (in.)...	
4 AS1/3501-6	50/40/10	[(45/0/-45/0)2/0/90]s	1.876	0.120...	Gr/Ep
5 AS1/3501-6	50/40/10	[(45/0/-45/0)2/0/90]s	1.875	0.118...	Ten. h.
6 AS1/3501-6	50/40/10	[(45/0/-45/0)2/0/90]s	1.874	0.120...	Tl. Csk
7 AS1/3501-6	50/40/10	[(45/0/-45/0)2/0/90]s	1.874	0.117...	St. Pr.
8 AS1/3501-6	50/40/10	[(45/0/-45/0)2/0/90]s	1.875	0.120...	St. Csk
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
803	.	.	.	.	.
804	.....	.....	.....	.....	.....

A hard copy of these tables are attached in Appendices A-1 to A-3. The first two Appendices contain 26 columns (from A to Z) while the last contains 30 columns (from A to Z to AD). If one clicks the column number at any column and goes to "sort" under the manual "Data," then he can rank the data in either ascending or descending order.

## 1.8 CONCLUSION

In the course of this work, the effects of many parameters on the bearing strength of bolted composite structures have been discussed. Among these parameters, lateral constraint provided by applying fastener torque stands out because it can improve the joint strength considerably. On the other hand, the harmful effects caused by human and machining parameters cannot be overlooked.

Limited test results show that these parameters can reduce the joining strength of composite structures by as much as 50 percent.

Comparing the bearing strength curves versus the W/D and e/D ratios, the former changes the slope more abruptly than the latter. When these ratios reach their critical values, the failure modes change from tension and shearout, respectively, to bearing. Their fracture strengths approach the same limit, namely, bearing strength.

Most investigators in this area focus on achieving full bearing strength. The reason is that this kind of failure mode is less catastrophic than the other two. However, one must keep in mind that achieving full bearing strength often does not produce optimum load-transfer efficiency. The calculation of gross strength for a laminate with bolted-joints is a good check for the efficiency.

The application of bolted-joints to composite structures has the advantages that it is a simple and cost effective method. This process has the disadvantage that it removes a considerable amounts of good material, which in turn introduces a significant stress concentration around the hole. The joining efficiency is considered medium to low. It is a great challenge to improve the efficiency of this joining method.

The testing of bolted joints with a single bolt, two bolts in a line, and three bolts in a line between composite to metal and composite to composite have been standardized in military handbooks. Details of the testing procedure and the specimen configuration can be found in Refs. [49] and [50].

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## **Chapter 2**

### **Adhesives and Bonded Joints**

#### **2.1 INTRODUCTION**

The study of structural adhesives and bonded joints of laminated composites and metals consisted of a literature search in the following publications: Journal of Adhesion, ASTM STP, International Journal of Adhesion and Adhesives, Journal of Composite Materials, Composites Science and Technology, Proceedings of SAMPE International Conference and Exhibition, Composites, books, NASA/DoD Technical Reports, technical reports from the commercial aircraft sectors, and technical reports from national laboratories, universities and centers. A listing of all documents researched on structural adhesives and bonded joints is included at the end of this chapter.

Adhesive joints in structures can provide higher load transferring efficiency than mechanical joints. With adhesive joints, material is not removed (in the form of drilled holes) from structures or structural components as in the case for mechanical joints. Generally, mechanical joints result in higher effective stress concentrations than do bonded joints. For these reasons, bonded joints have higher load carrying capability than mechanical joints provided the adhesives used have good mechanical properties and the surface preparation is good.

Bonded joints have been used in many areas of aircraft and aerospace structures [2-1 to 2-4]. The attaching mechanism that is used for bonded joints is adhesive. Most structural adhesives are cured at elevated temperature although many will cure at room temperature given sufficient time. Adhesives have been used exclusively in some structural components such as sandwich beams or sandwich plates. They are also one of the key components used for repair of aircraft structures [2-5 to 2-7]. Although the role of adhesives is very important in aircraft structures, the characterization methods for their

mechanical properties are not as well developed as they are for composite laminates. The available testing methods will be discussed briefly in the following sections.

In 1982, Matthews et al. [2-8] wrote a review paper in the area of adhesive bonded joints in fiber-reinforced plastics. The authors addressed theoretical works related to the lap shear test. On the contrary, this study places more attention on experimental work concerning adhesive properties in bulk and bonded form. This chapter discusses the properties of adhesives in bulk form and adhesive properties in lap shear configuration.

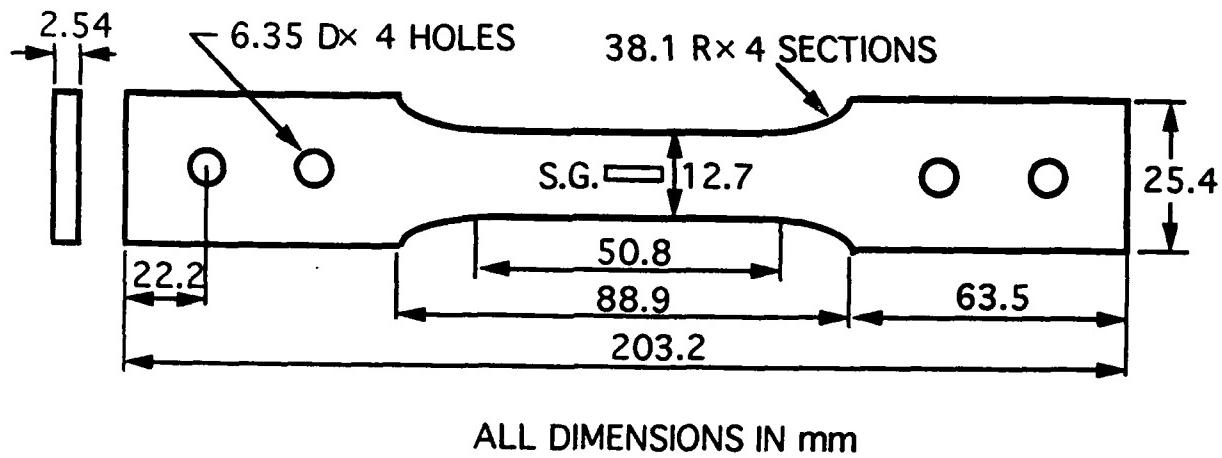
## 2.2 TESTING METHODS FOR ADHESIVE

For a stress and strength analysis, mechanical properties, including moduli and Poisson's ratio are required. In addition to these, tensile, compressive and shear strength parameters are needed for failure analysis. In the application of fracture mechanics analysis, the values of critical energy release rate, denoted by  $G_{IC}$ ,  $G_{IIC}$  and  $G_{IIIC}$  are needed. The testing methods associated with all these parameters are discussed in the following sections.

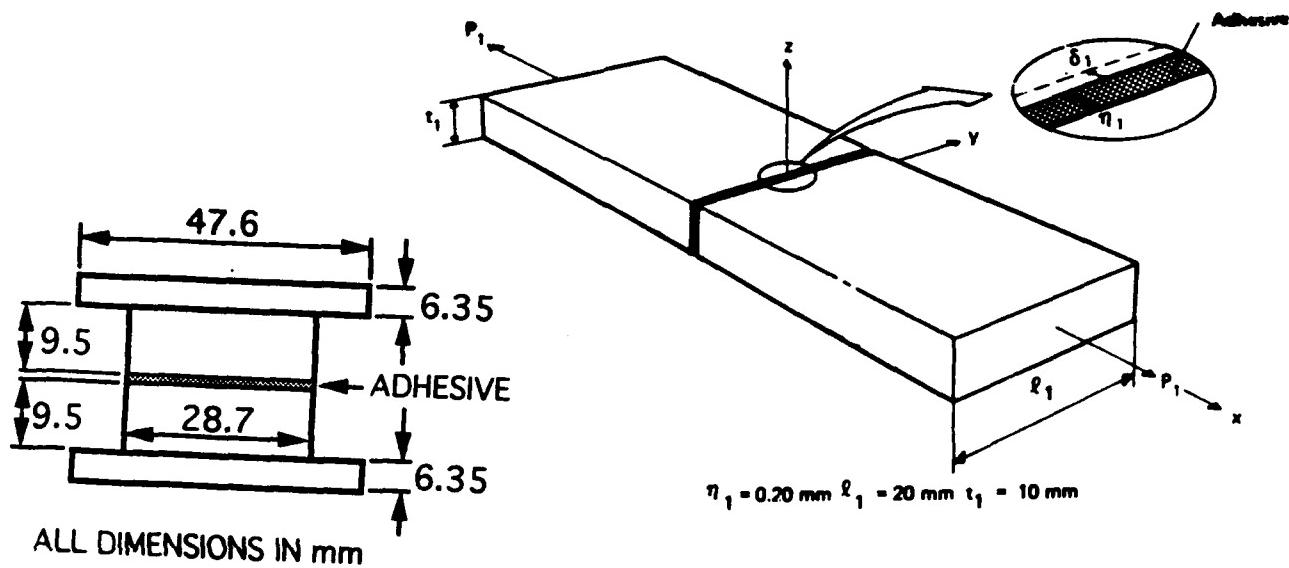
### 2.2.1 Normal and Mode I Properties

Elastic properties and strengths can be evaluated using the following tests: (1) flat dog bone tension, Figure 2-1; (2) butt joint with circular, Figure 2-2 (ASTM D 897), rectangular, Figure 2-3, or square cross-sectional shape loaded in tension or compression; (3) sandwich flatwise tensile test, Figure 2-4 (ASTM C 297); (4) butt joint tension with cylindrical tubes, Figure 2-5; and (5) cross-lap tensile test, Figure 2-6 (ASTM D 1344).

The testing methods for determining Mode I critical energy release rate of adhesives include: (1) peel tests (which include T-peel ASTM D 1876, Figure 2-7; climbing drum peel, ASTM D 1781; and floating roller peel, ASTM D 3167); (2) thick blister (Figure 2-8); (3) butt joint tension; and (4) double cantilever beam (DCB). Specimens tested with butt joint in tension have 2% of mode II loading while the peel and the thick blister tests each contain 19 percent of mode II loading.

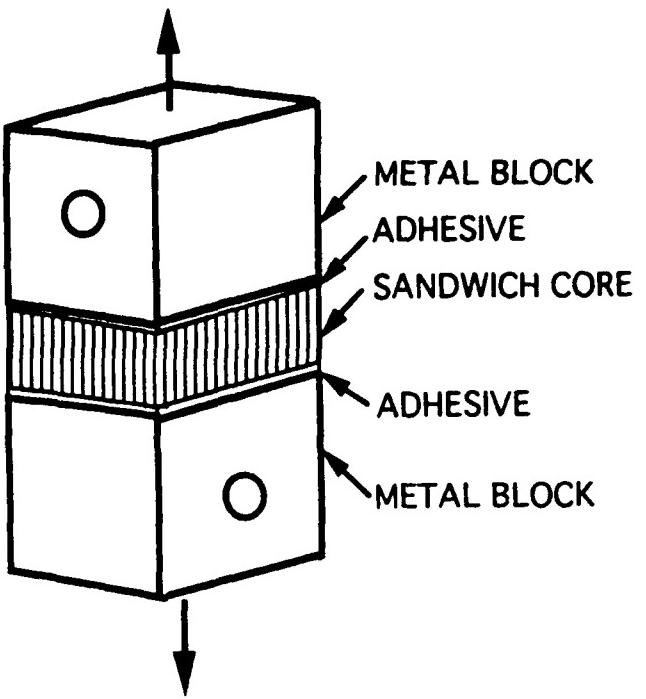


**Figure 2-1. Dog bone flat specimen for tensile test.**

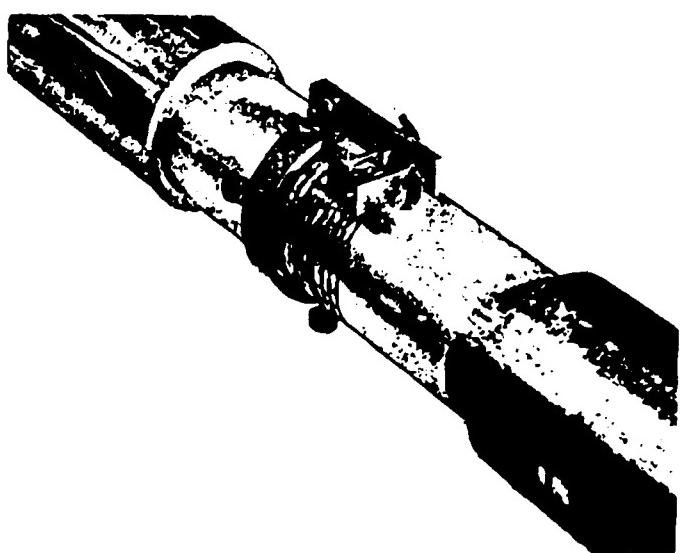


**Figure 2-2. Cylindrical  
butt-joint (ASTM D 897)**

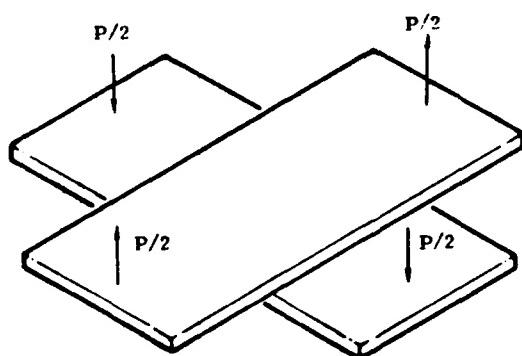
**Figure 2-3. Rectangular  
butt-joint.**



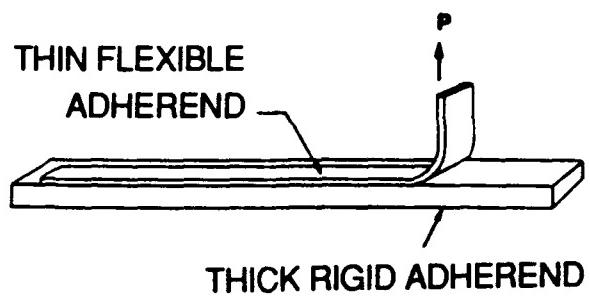
**Figure 2-4. Sandwich tensile test specimen.**



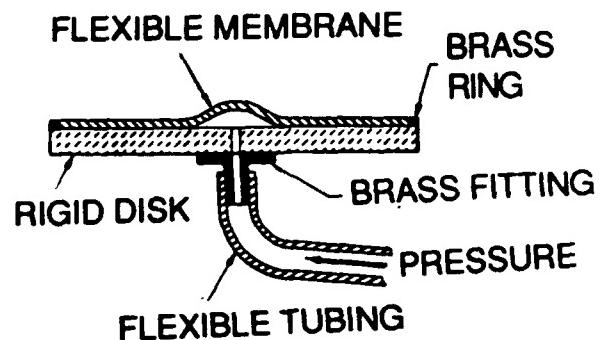
**Figure 2-5. Butt-joint with cylindrical tubes.**



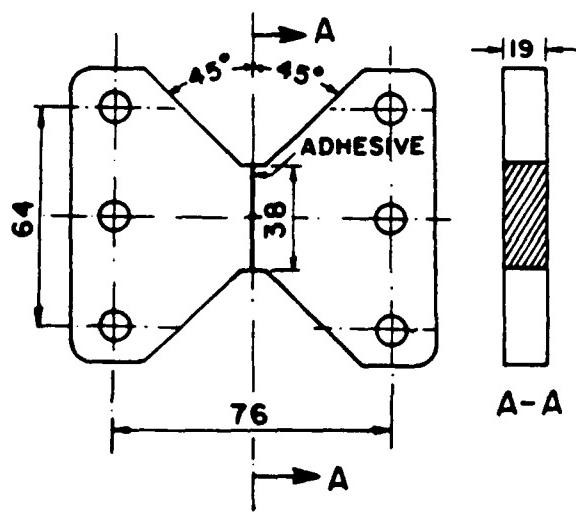
**Figure 2-6. Cross-lap specimen.**



**Figure 2-7.** Peel test specimen.



**Figure 2-8.** Blister test specimen.



**Figure 2-9.** Stiff adherend specimen and fixture.

### **2.2.2 Shear and Mode II Properties**

Shear modulus and strength of adhesives can be evaluated using: (1) stiff adherend specimen, Figure 2-9; (2) butt joint with cylinders loaded in torsion (Figure 2-5); (3) bulk adhesive tube loaded in torsion, Figure 2-10; (4) thick adherend lap shear, Figure 2-11 (ASTM D 3983); (5) double lap shear (ASTM D 3528); (6) Napkin ring, Figure 2-12 (ASTM E 229-70 [2-9]); and (7) blocks loaded in compression, ASTM D 905-86 [2-10]. Testing methods of Mode II component include: (1) thin blister; (2) cylinder pull-out, Figure 2-13; and (3) cracked lap shear, Figure 2-14.

### **2.2.3 Mode III Properties**

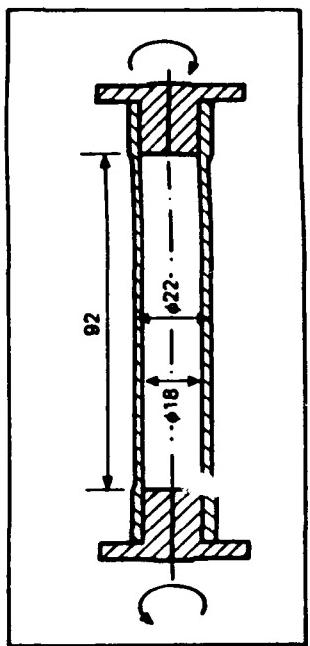
Mode III critical strain energy release rate of adhesives can be measured using: (1) thick cracked-lap-shear specimen with out-of-plane loading, Figure 2-15; and (2) butt joint in torsion, Figure 2-2.

### **2.2.4 Mixed-Mode Loading**

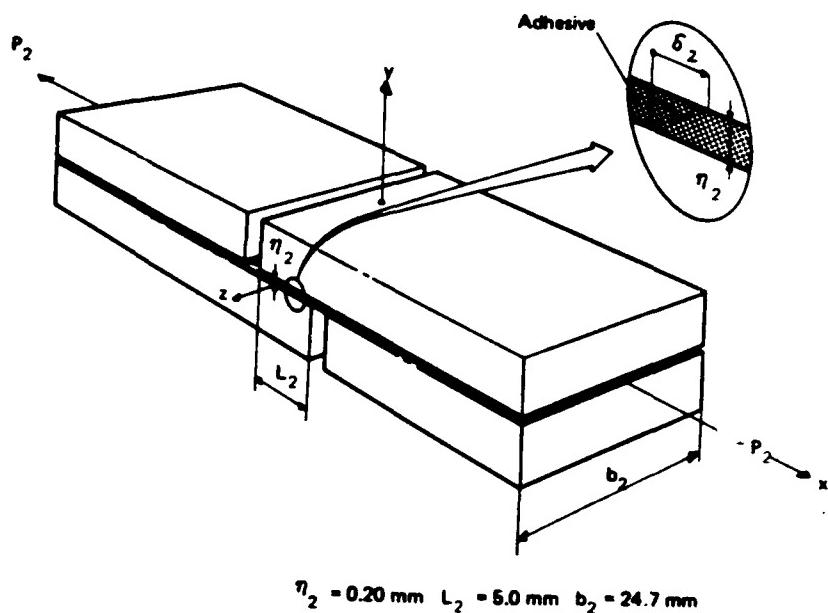
Mixed-mode testing methods of adhesives include: (1) cracked lap-shear, Figure 2-14 (example can be found in Ref. [2-11]); (2) scarf joint [2-12]; (3) stiff adherend specimen with off-axis loading, Figure 2-16 (example can be found in Ref. [2-13]); (4) independently loaded mixed-mode (ILMM), Figure 2-17 [2-14]; and (5) flat coupon with adhesive-adherend bonded at 45° to the loading axis, Figure 2-18 [2-15]. Extremely limited studies have been done in this area. Stress analysis is critically needed to examine the uniformity of the stress distribution in the test specimens in order to obtain accurate material properties.

## **2.3 ADHESIVE PROPERTIES**

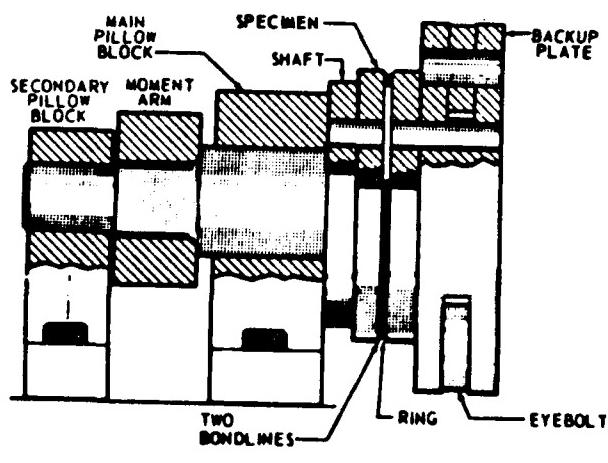
The results of adhesive property tests include normal stress-strain curve and strength, shear stress-strain curve and strength, the adhesive properties due to the effects of curing temperature, time and cool down rate, the creep properties, and thickness effects on the adhesive properties. More detailed discussion is given in the following sections.



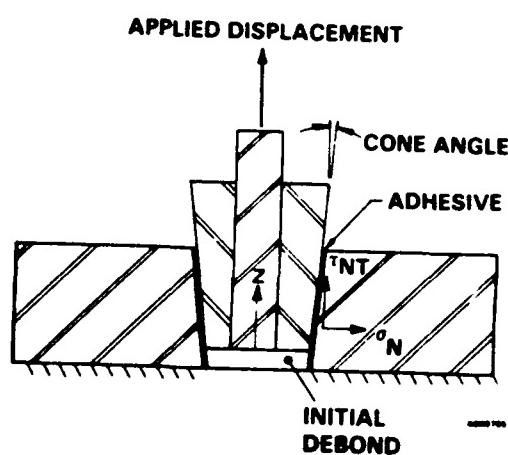
**Figure 2-10.** Bulk adhesive tube.



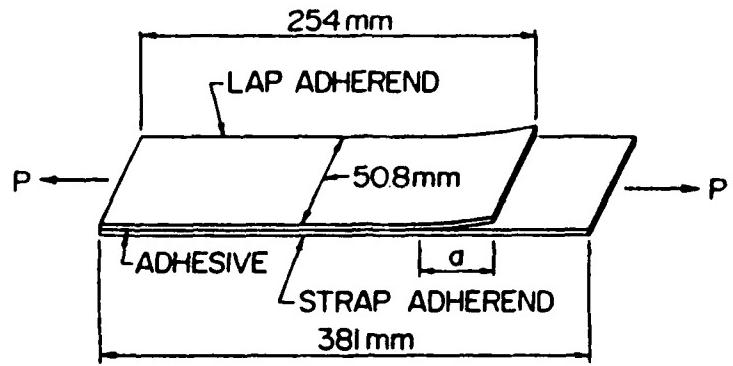
**Figure 2-11.** Thick adherend lap shear specimen.



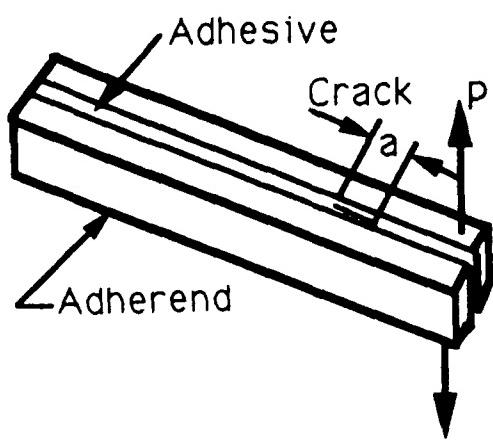
**Figure 2-12.** Napkin ring test (ASTM E 229)



**Figure 2-13.** Cone test (cylinder pull-out).



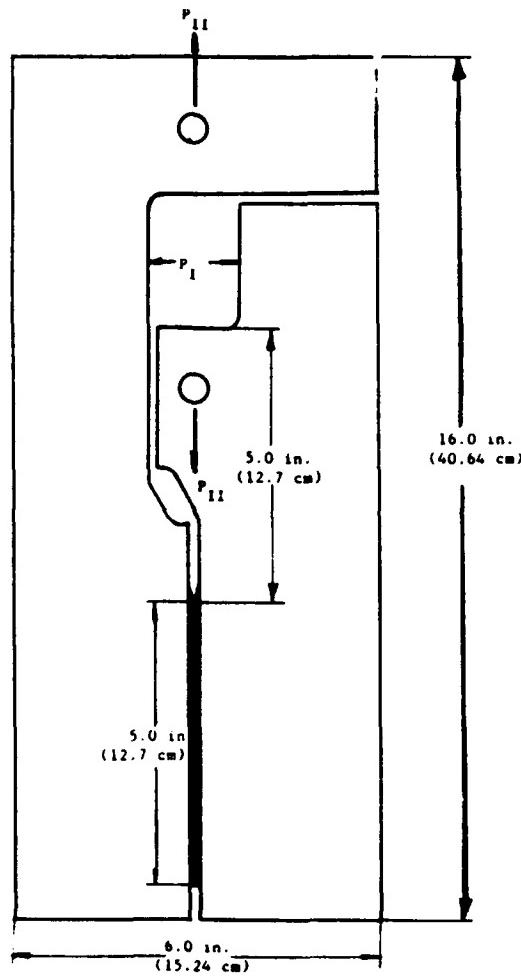
**Figure 2-14.** Cracked lap-shear specimen.



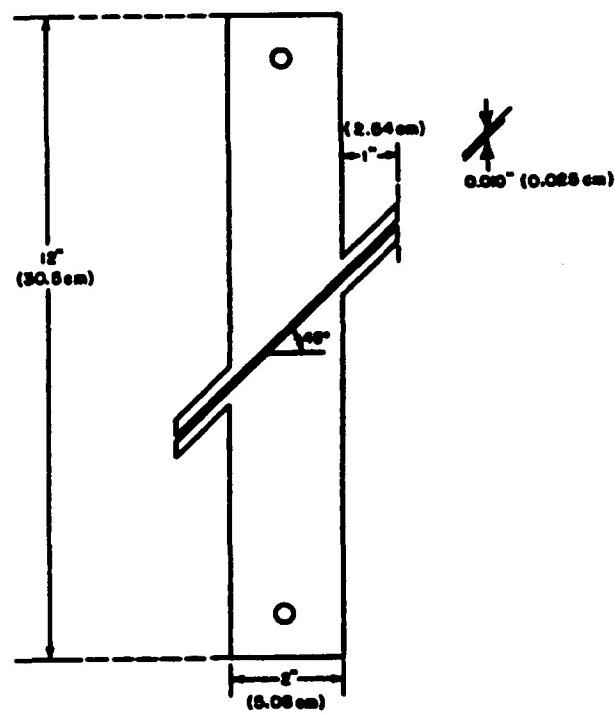
**Figure 2-15.** Thick cracked-lap-shear specimen.



**Figure 2-16.** Stiff adherend specimen with off-axis loading.



**Figure 2-17. ILMM specimen.**



**Figure 2-18. 45° mixed-mode flat specimen.**

### 2.3.1 Normal Properties

Adhesive materials are generally very nonlinear and temperature dependent. To describe the nonlinear stress-strain relationship, many engineers have employed the Ramberg-Osgood equation [2-16] which:

$$\epsilon = \frac{\sigma}{E} + K \sigma^n \quad (1)$$

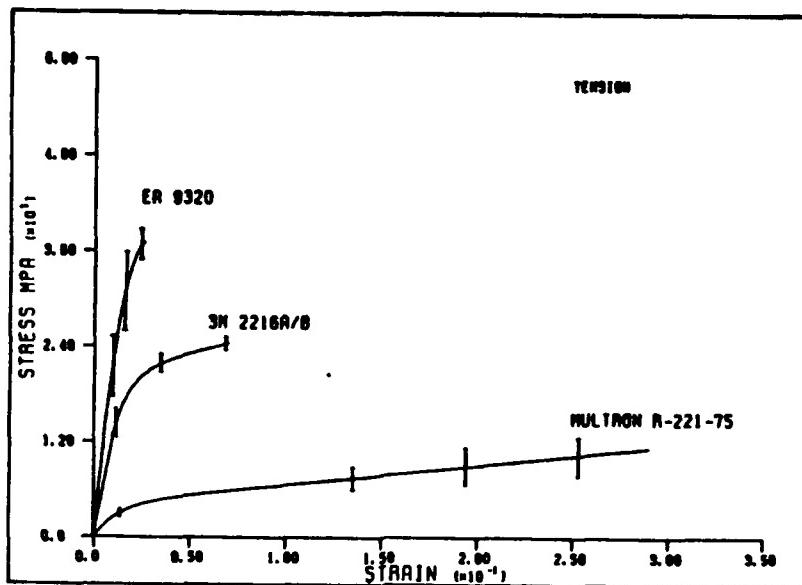
where the first and second terms on the right-hand side of the equation represent elastic and plastic strains, respectively, and where E, K and n are material parameters. Another equation which will be mentioned later is the modified Bingham model [2-17]:

$$\sigma(\epsilon) = E\epsilon, \text{ for } 0 < \sigma < \theta \quad (2)$$

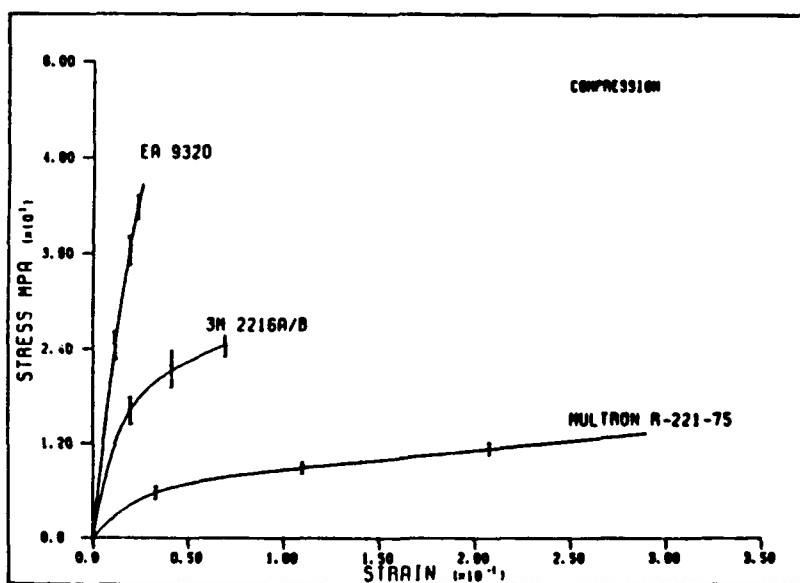
$$\sigma(\epsilon) = \theta + ER\tau[1 - e^{-(\epsilon - \epsilon_0)/R\tau}], \text{ for } 0 < \sigma < Y$$

where  $\theta$  and  $Y$  denote the elastic limit and yield stress, respectively;  $R$  is the strain rate,  $\tau$  is the relaxation time, and  $\epsilon_0$  is the elastic limit strain.

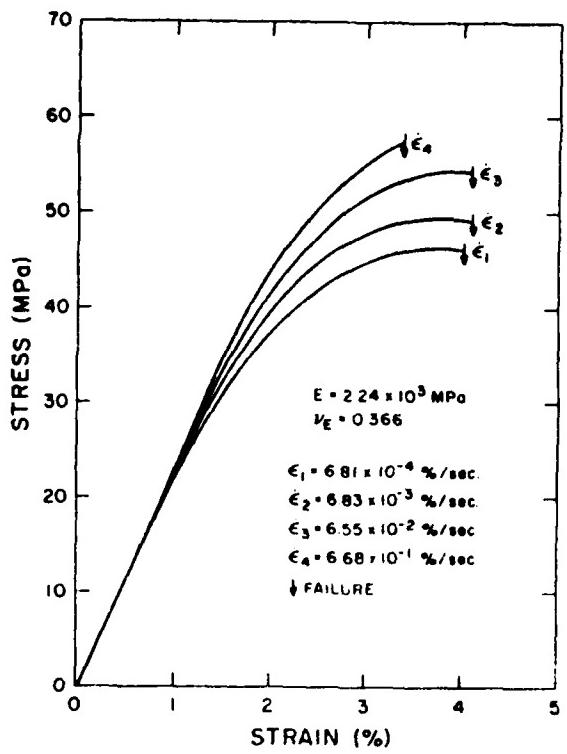
**Flat Dog Bone.** The normal components of the stress-strain curves for Hysol EA 9320, 3M Company 2216A/B and MULTRON R-221-75 adhesives have been studied under tensile and compressive loadings [2-18]. Flat dog bone specimens were used for the tensile tests whereas an adhesive block with a square cross-sectional shape was used for the compression tests. The shape of the stress-strain curves as well as the strength and fracture strain values for each adhesive are very similar for tensile, Figure 2-19, and compressive loadings, Figure 2-20. However, the failure modes obtained from these tests were not reported. Brinson et al. [2-19] also used dog bone specimens to characterize the normal stress-strain curves of adhesives. Figures 2-21 and 2-22 illustrate that the stress-strain behaviors of Metlbond 1113 and Metlbond 1113-2 are very nonlinear. They are quite sensitive to the strain rate applied. A higher strain rate results in a higher fracture strength for the adhesive. These authors also showed that the stress-strain curves of these adhesives can be characterized more accurately using a modified Bingham model, Eq. (2), rather than the Ramberg-Osgood model, Eq. (1). However, the Ramberg-Osgood equation is more widely used because of its simplicity.



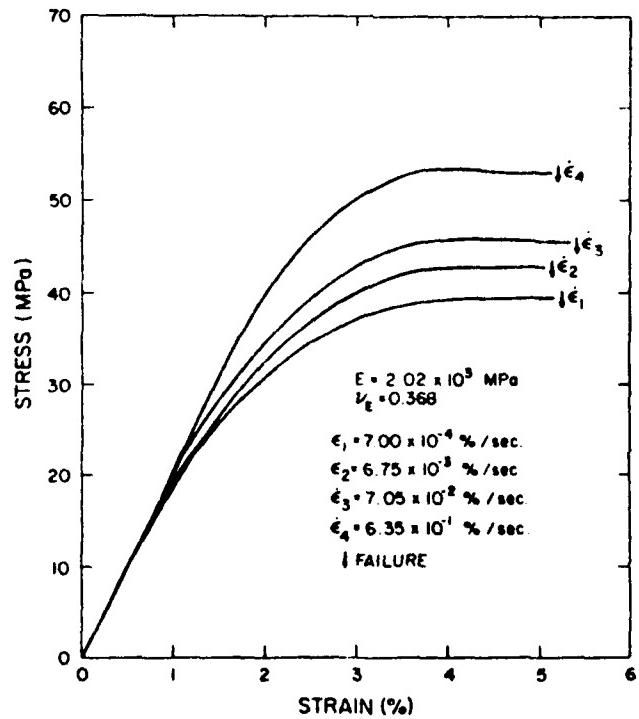
**Figure 2-19. Tensile stress-strain curves of adhesives.**



**Figure 2-20. Compressive stress-strain curves of adhesives.**



**Figure 2-21.** Tensile stress-strain .vs. strain-rate relations of Metlbond 1113.



**Figure 2-22.** Tensile stress-strain .vs. strain-rate relations of Metlbond 1113-2.

Other work that uses the dog bone flat specimens can be found in Ref. [2-20], which presents the tensile modulus and Poisson's ratio of Redux 322 epoxy film and Eccobond 45 LV two-part epoxy paste.

**Butt Joint-Thick Adherend.** The tensile modulus and Poisson's ratio of an adhesive can be measured by methods other than the flat dog bone. For instance, Jangblad et al. [2-21] evaluated these parameters using a combination method. With the assumption that the adherends are all rigid, two simple equations were obtained with Young's modulus and Poisson's ratio as unknowns. These unknowns can be solved using experimental results from butt joint (Figure 2-3) and thick adherend specimens (Figure 2-11). Jangblad et al. also performed tensile tests using flat coupons of bulk adhesive. The results obtained from the combination method (2504 MPa and 0.34) for FM-300K agree quite well with those measured using bulk adhesive (flat specimen, 2330 MPa and 0.39).

**Butt Joint.** The result of this test normally reported by experimentalists is simply the failure load divided by the cross-sectional area of the adhesive. The analyses performed by Messer [2-22] and Anderson, et al. [2-23] have shown that the axial stress component at the bonded edge tends to be unbounded. This result invalidates the application of maximum stress failure criteria and the simple idea of failure divided by the total cross-sectional area. With the development of a modified tensile test apparatus [2-23], the result of the tensile strength of polyurethane (Solithane 113) adhesive is 76% higher than that obtained using a standard button test method. Associated with this increase in strength was a reduction in the data coefficient of variation. The reported tensile strengths for this adhesive were 5.8 and 5.2 ksi for adhesive thickness equal to 0.065 and 0.006 inch, respectively. Additional data were reported in Refs. [2-24] and [2-25].

**$G_{IC}$ .** In 1988, Russell [2-26] used a double cantilever beam (DCB) method to measure the  $G_{IC}$  values for FM-300K, FM-300 and EA-9321 adhesives as a function of temperature. Figure 2-23 shows that  $G_{IC}$  values for the first two adhesives increase as temperature increases. On the other hand,  $G_{IC}$  for EA-9321 adhesive increases slightly to 50°C and then it decreases. Mall and Yun [2-27] reported that  $G_{IC}$  values for FM-400, FM-300 and EC-

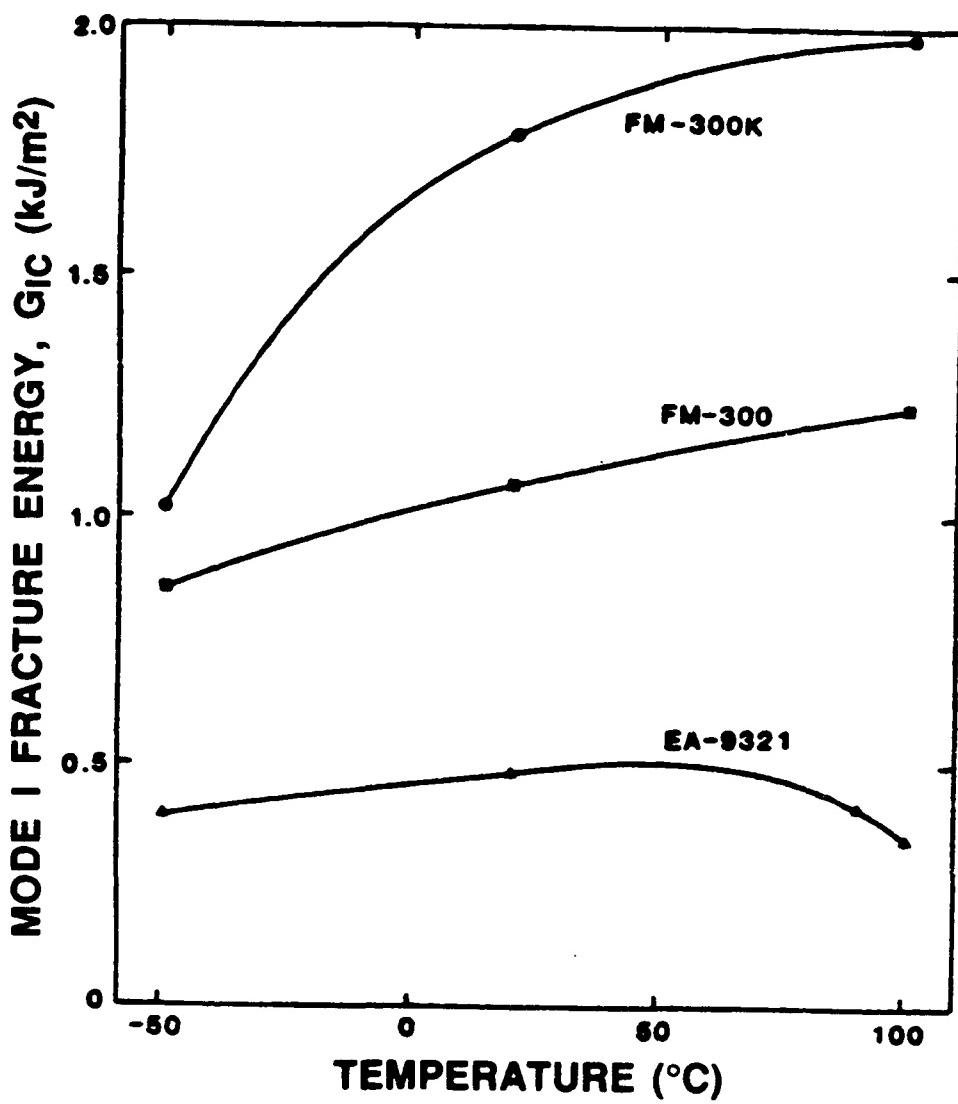


Figure 2-23. Effect of temperature on the  $G_{IC}$  of adhesives.

3445 were 603, 933 and 888 J/m<sup>2</sup>, respectively, where FM-300 was in close agreement with Russell's result. The  $G_{IC}$  values for other adhesives can be found in Refs. [2-28] and [2-29].

### 2.3.2 Shear Properties

Shear stress-strain behavior of adhesives can be determined using some of the shear testing methods mentioned above. Some of the representative results are discussed in the following section.

**Butt Joint with Cylindrical Tubes.** As early as 1963, Kuenzi and Stevens [2-30] characterized the shear stress-strain behavior of adhesives using a butt joint with cylindrical tubes, Figure 2-5. The materials studied include Redux K-6, AF-6, MN3C, Epon VIII, Metlbond 4021, FM 47, Epon 422J, Metlbond 408 and FM 1000 (Figure 2-24). A strength of materials approach was applied for data interpretation. No analysis has been performed to confirm the data measured.

**Stiff Adherend Specimen.** Weissberg and Arcan [2-13] performed a finite element analysis for a stiff adherend specimen loaded along the bondline direction. They compared this test specimen with a thick adherend specimen and showed that: (1) the peak value of the normal stress component (at the corner of the adhesive-adherend interface) in the adhesive is less than half of that in the thick adherend lap shear specimen; and (2) the normal stress decays much faster than that of the latter specimen. Shear strain was measured using a crack opening displacement gauge located across the adhesive. The result for EA 9321 adhesive is illustrated in Figure 2-25. The authors also performed a fracture mechanics analysis and confirmed with limited experimental data that the product of fracture shear stress and the normalized compliance change rate is a constant. That is, it is independent of the crack length.

**Thick Adherend Lap Shear.** In 1975, Renton and Vinson [2-31] characterized elastic properties, E, G and v, of EA 951 film adhesive using the thick adherend lap shear test. An extensometer was placed on the outside surfaces of the fixture to measure the shear deformation. The deformation of the fixture was then subtracted from the measured deformation to obtain the adhesive deformation. The calculation was conducted using a strength of

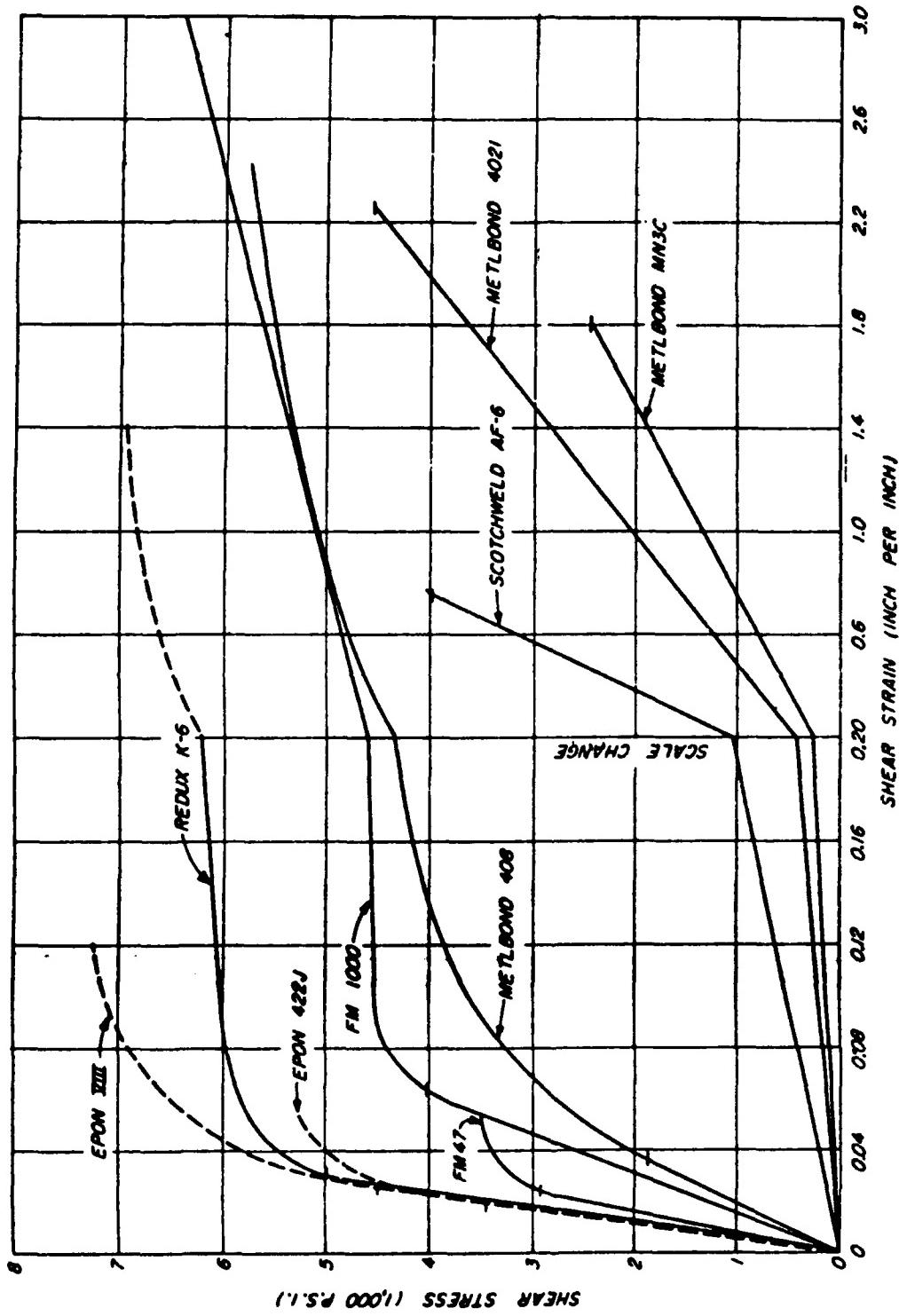


Figure 2-24. Shear stress-strain curves of adhesives measured by butt-joint with cylindrical tubes.

materials approach. The result shows that the tensile modulus is linearly dependent on the adhesive thickness. This result leads to uncertainty with respect to the applicability and accuracy of the thick adherend lap shear test.

Recently (1988), Post et al. [2-32] utilized a Moire Interferometry method to study the strain distribution of FM-73M adhesive in a thick adherend lap shear specimen, Figure 2-26. Aluminum, 2024-T3, was used for the adherend. The shear stress-strain curve was obtained nearly to the ultimate fracture of the specimen. They showed that the shear strain is mostly uniform in the adhesive except at the two ends. The transverse strain component was one to two orders of magnitude smaller than the shear strain. Therefore, shear stress-strain behavior should be accurate if measurements were made in the central portion of the adhesive. Deformations should be measured at points within the adhesive in order to achieve high accuracy.

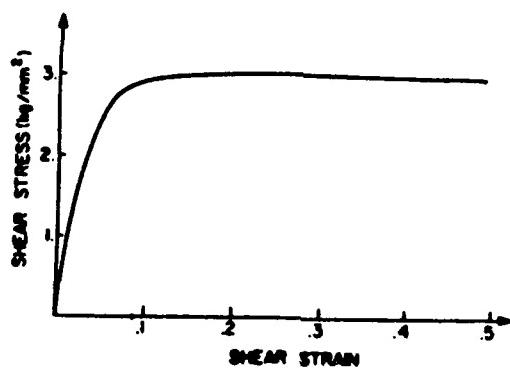
The shear stress-strain relations for Cybond 1115 and BR-100 (two-part epoxy paste adhesives) were characterized by American Cyanamid and presented in Ref. [2-33] using the thick adherend lap shear specimen. A KGR-1 extensometer was used to measure the deformation. The result is shown in Figure 2-27.

**Napkin Ring Shear Test.** The shear stress-strain behavior of the FM-73 adhesive can be found in Ref. [2-34] and is shown in Figure 2-28. Comparing the results in Figures 2-26 and 2-28, it is interesting to note that shear strength and fracture strain evaluated by the napkin shear test are almost twice as high as those determined by a thick adherend lap shear test. On the contrary, the initial modulus (60 ksi) is only half that obtained from the adherend lap shear test.

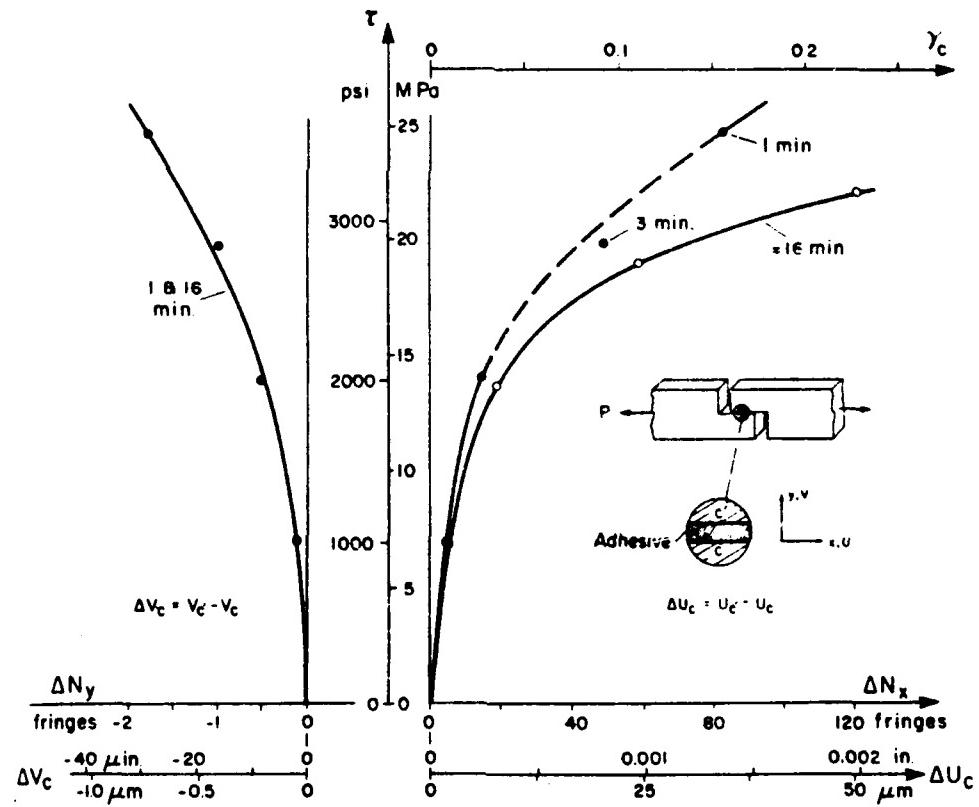
**Torsion Pendulum Test.** Jeandrou [2-20] showed that the shear moduli for the Redux 322 epoxy film and Eccobond 45 LV epoxy paste, evaluated using a bulk adhesive tube, Figure 2-10 (NFT 51104) agreed very well with the thick adherend lap shear tests. The measurements using these two test methods both agree well with the value calculated from the following equation:

$$G = \frac{E}{2(1 + v)} \quad (3)$$

where G, E and v denote shear modulus, tensile modulus and Poisson's ratio,



**Figure 2-25.** Shear stress-strain curve of EA 9321 adhesive measured by stiff adherend specimen.



**Figure 2-26.** Shear stress-strain curve of FM-73M adhesive evaluated using thick adherend specimen with Moire Interferometry.

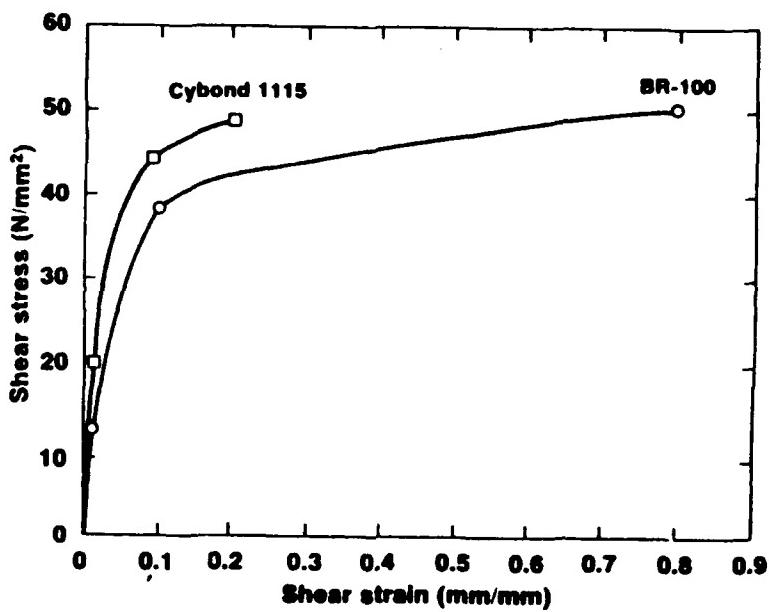


Figure 2-27. Shear stress-strain curves of adhesives measured using thick adherend specimen.

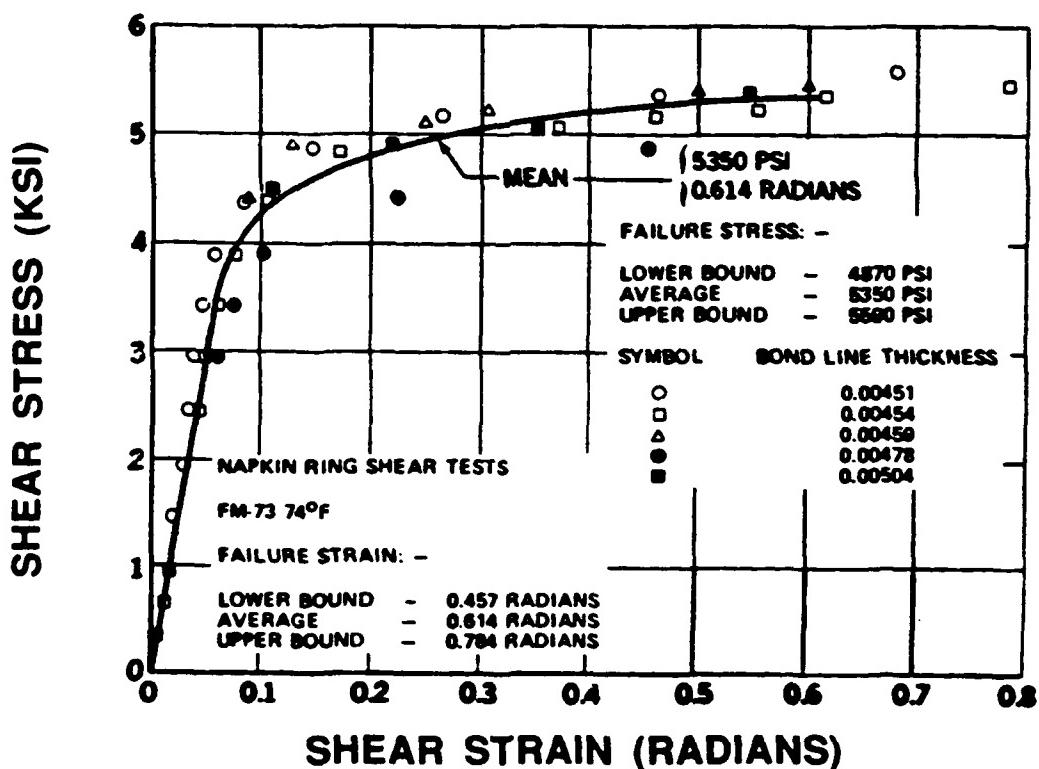


Figure 2-28. Shear stress-strain curve of FM-73 adhesive obtained using napkin ring tests.

respectively. Equation (3) is true for isotropic materials.

**$G_{IIC}$  and  $G_{IIIC}$ .** The mode II critical strain energy release rate for FM-300K, FM-300 and EA-9321 adhesives has been measured as a function of temperature by Russell [2-26] and plotted in Figure 2-29. The  $G_{IIC}$  for the first adhesive increases as temperature increases at low temperature. For temperature higher than room temperature,  $G_{IIC}$  decreases. The  $G_{IIC}$  values for the other two adhesives increase as temperature increases from -50°C to 100 °C. A very limited number of results for  $G_{IIC}$  and  $G_{IIIC}$  for Solithane 113 were reported by Anderson et al. [2-35] and [2-24].

### 2.3.3 Normal Versus Shear Stress-Strain Behaviors

Shear stress-strain curves of adhesives are normally much more nonlinear than their normal components. For instance, Figure 2-30 shows the comparison of the normal [2-19] and shear [2-36] stress-strain curves for Metlbond 1113 adhesive. One exception to this common behavior is AF-126-2 adhesive. Figure 2-31 shows that the extensional component [2-37] is more nonlinear than the shear component [2-38]. No other experimental data have shown or confirmed this unusual characteristic.

### 2.3.4 Adherend Thickness Effects

In 1977, Guess et al. [2-39] conducted tests with EC 2214 R paste adhesive and FM 123-5 film adhesive using thick adherend and standard lap shear tests (ASTM D 1002). Three different adhesive thicknesses (0.127, 0.254 and 0.508 mm) and four adherend thicknesses (0.127, 6.35, 12.7 and 2.54 mm) were tested. The result, Figure 2-32, shows that shear strengths only change slightly when thick adherend lap shear specimens with different thicknesses were used. However, the shear strengths obtained from thin adherend single lap shear tests are less than half (EC 2214 R) of those obtained using the thick adherend lap shear tests. Thin adherend single lap shear tests tend to give lower strength values because of eccentricity, high stress concentrations, introduction of a mixed-mode loading, etc. Figure 2-32 also reveals that a thicker adhesive only slightly reduces the lap shear strength. This agrees with the result reported by Renton and Vinson [2-40]. Unfortunately, the former authors did not report adhesive moduli. Therefore, the peculiar thickness effect of adhesive reported in [2-31] cannot be examined.

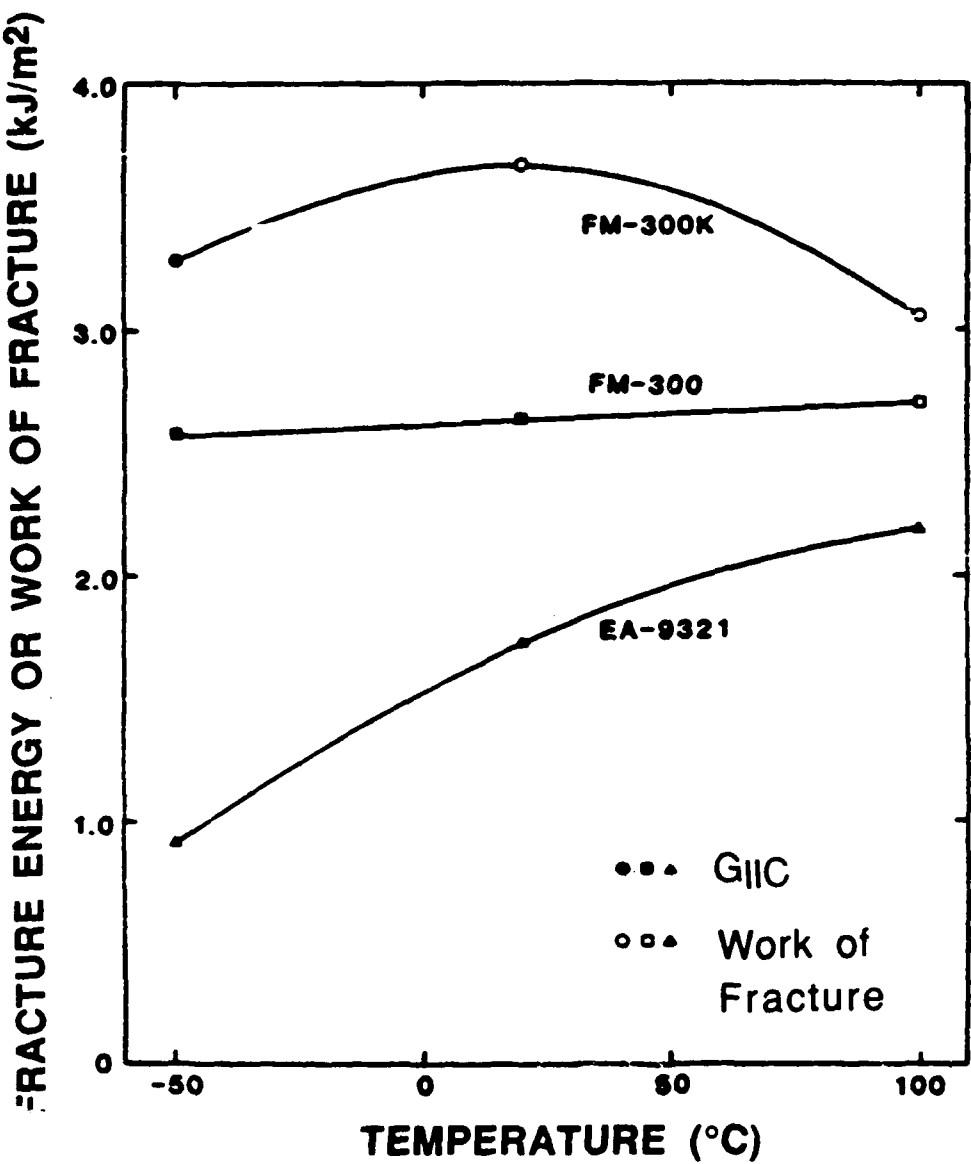
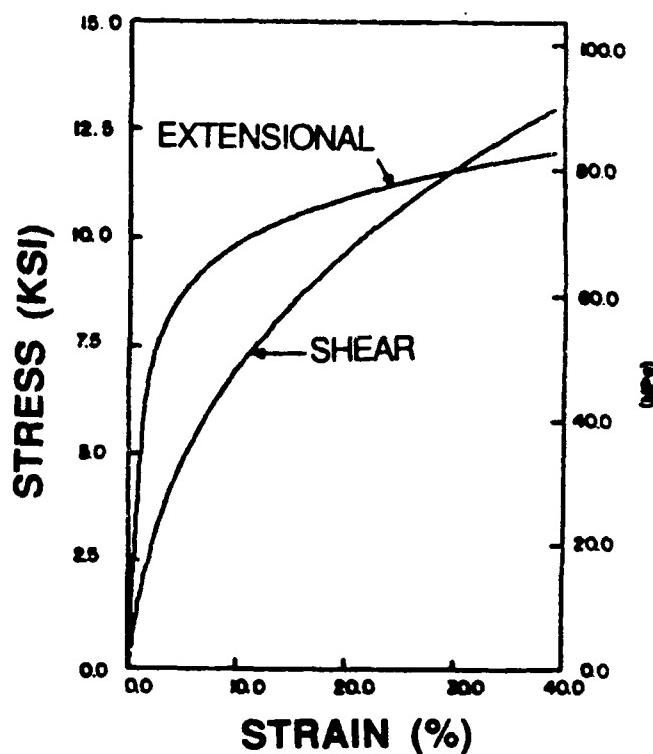
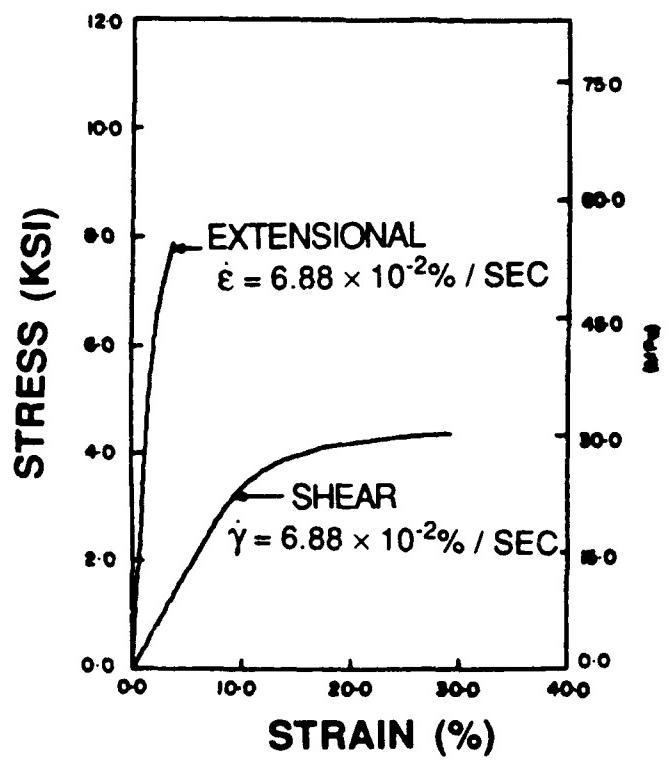


Figure 2-29. Effect of temperature on  $G_{IIc}$  values of adhesives.



**Figure 2-30.** Stress-strain curves of Metlbond 1113 adhesive.

**Figure 2-31.** Stress-strain curves of AF-126-2 adhesive.

### **2.3.5 Moisture Effects**

Recently, in 1988, Jurf [2-41] studied the effects of moisture on the FM 73M and FM 300M adhesives using a thick adherend lap shear test. He concluded that moisture has no effect on adhesive modulus at room temperature but has significant effects at elevated temperature for these two adhesives, Figure 2-33. The shear modulus-temperature relation for FM 73M is basically the same as that for FM 300M. The shear strength of these adhesives was also reduced significantly due to increase in moisture content.

### **2.3.6 Creep/Stress Relaxation Properties**

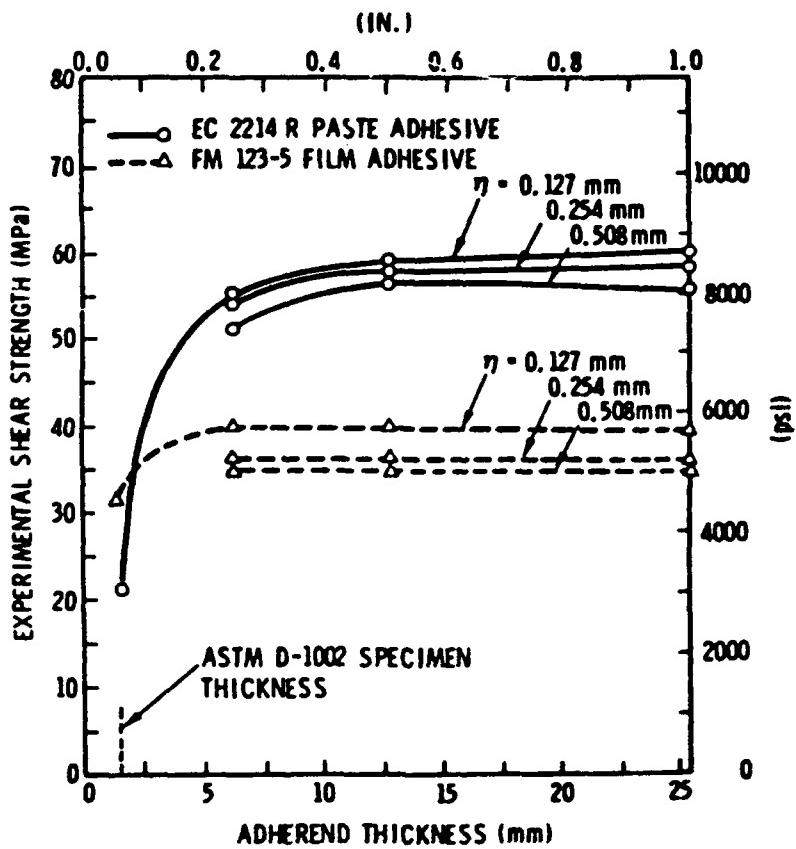
Extremely few studies have been conducted in the area of creep and stress relaxation properties of adhesives. In 1975, Brinson et al. [2-19] tested Metlbond 1113 (Figure 2-34) and Metlbond 1113-2 (Figure 2-35). The stress relaxations are significant after only 1 minute of applied constant strain. Beyond 1 minute, stress relaxation was small. Another effort in this area was presented by Seago [2-42]. The author tested 13 adhesives with different primers, surface preparation, cure cycles and carriers. The result showed large difference in cyclic time to failure among the adhesive systems.

### **2.3.7 Effects of Cure Temperature and Time**

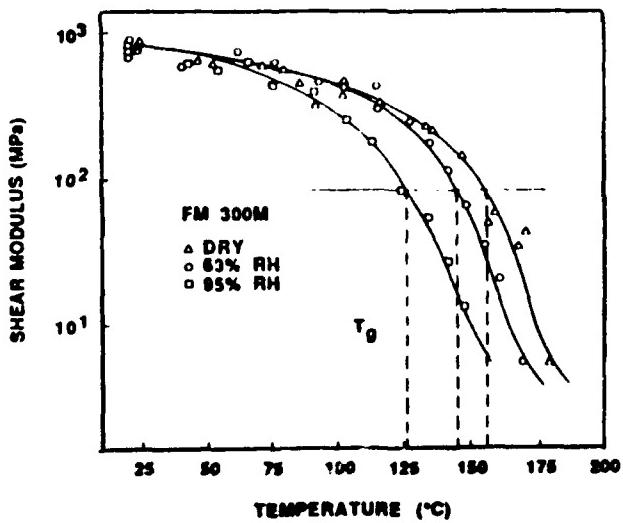
Sancaktar, et al. [2-43] used flat dog bone specimens to study the effects of curing time, temperature, and cool down rate on tensile strength of Metlbond 1113-2 and Metlbond 1113 adhesives. Figure 2-36 shows that tensile strength decreases if curing time was less than 120 minutes. Rapid cool-down reduced tensile strength of these adhesives by 5-15%.

## **2.4 JOINING METHODS FOR BONDED JOINTS**

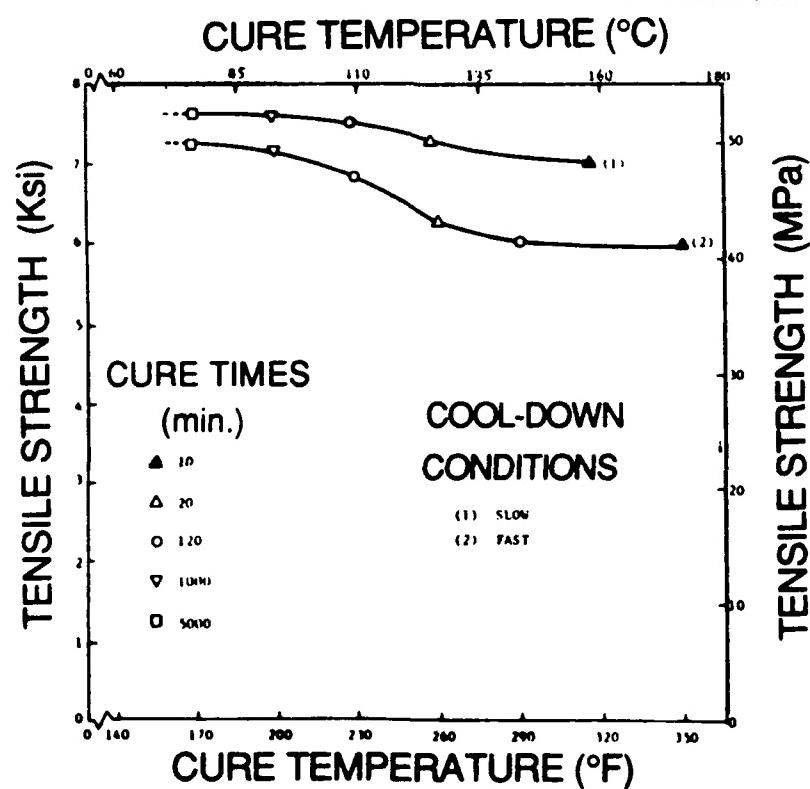
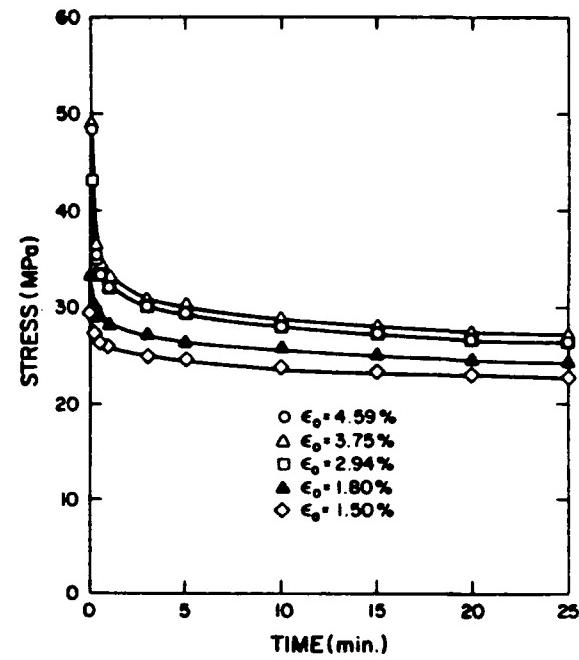
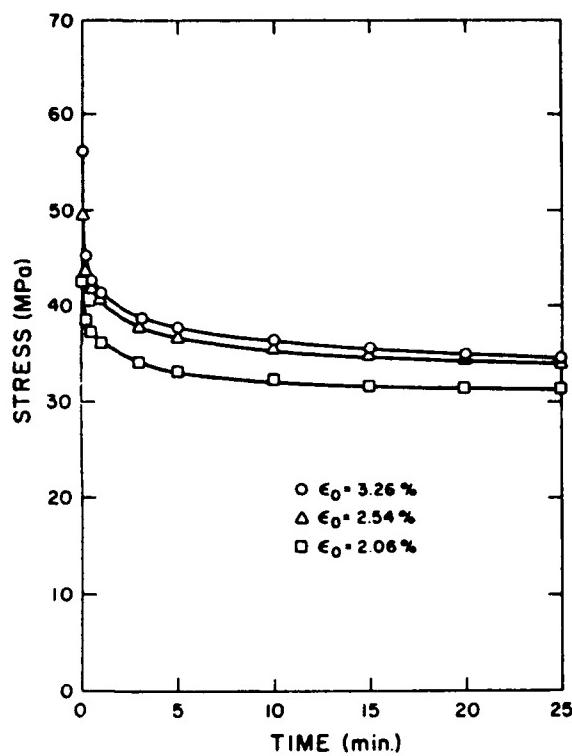
There are five basic types of bonded joints in composites: (1) single lap joints; (2) double lap joints; (3) strap joints; (4) stepped lap joints; and (5) scarf joints [2-44] to [2-47]. Each type of joint contains several variations as shown in Figure 2-37.

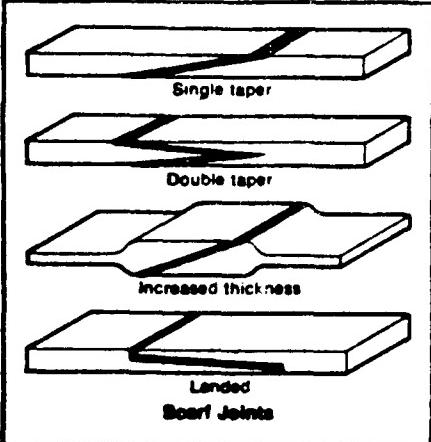
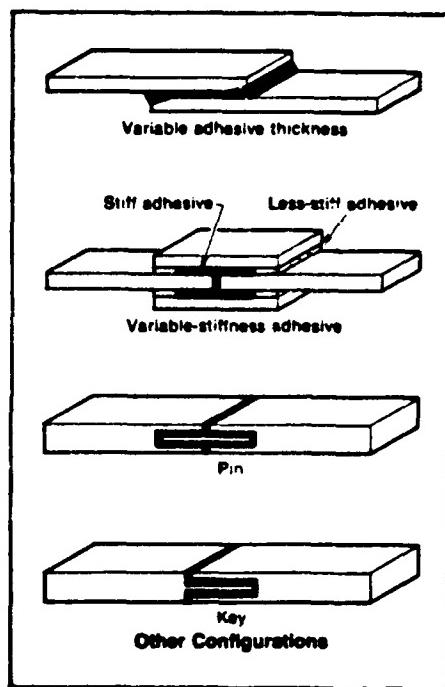
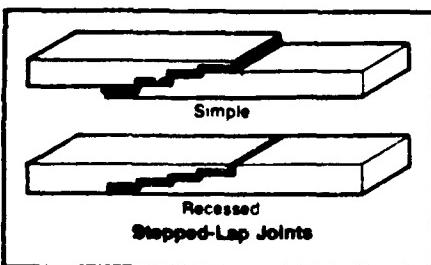
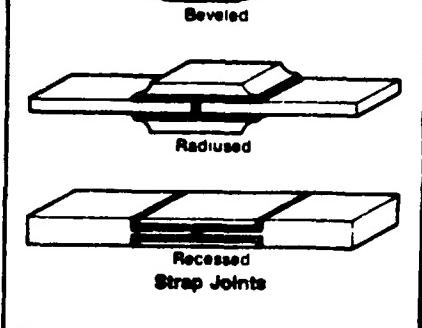
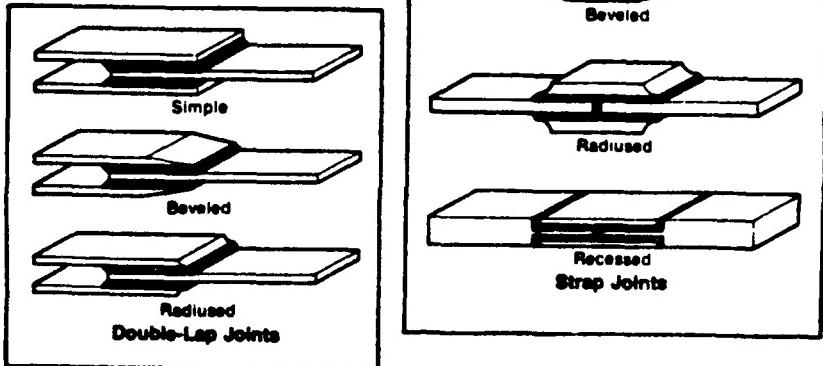
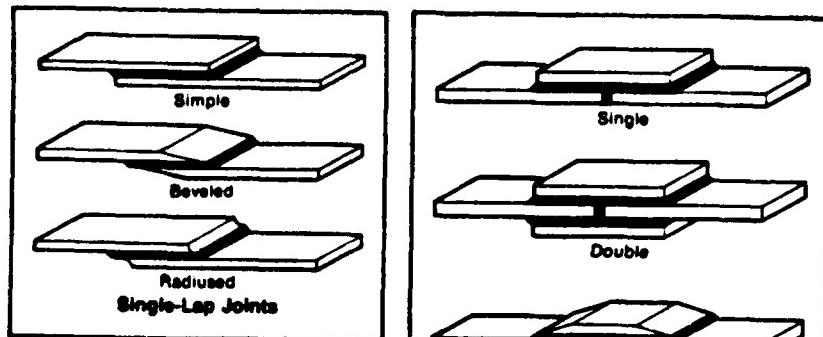


**Figure 2-32. Effects of adherend and adhesive thicknesses of lap shear strength of adhesives.**



**Figure 2-33. Effects of moisture and temperature on shear modulus of FM-300M adhesive.**





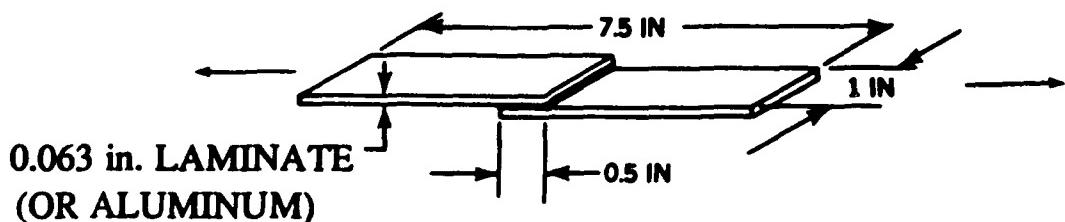
**Figure 2-37. Variations of bonded Joints.**

## 2.5 LAP SHEAR TESTING

The American Society for Testing and Materials has adopted the single lap shear specimen, Figure 2-38 (ASTM D 1002), to evaluate lap shear properties of adhesively bonded joints. The stress analysis presented in Ref. [2-48] along the bondlines of single and double lap joints showed that adhesives were subjected to mixed-mode loading of nearly equal magnitude. Therefore, *this type of bonded joint cannot be used as a characterization method for adhesives. Rather, it should be treated as a quality control test.* The mechanical properties of structural adhesives in bulk form normally do not directly correlate to the properties in bonded form. The thermal residual stresses due to the curing process depend on the adhesive as well as on the adherend materials.

## 2.6. LAP SHEAR TESTING RESULTS

Experimental data for single lap shear testing of composite materials are extensive. Some typical results will be discussed in the following paragraphs.



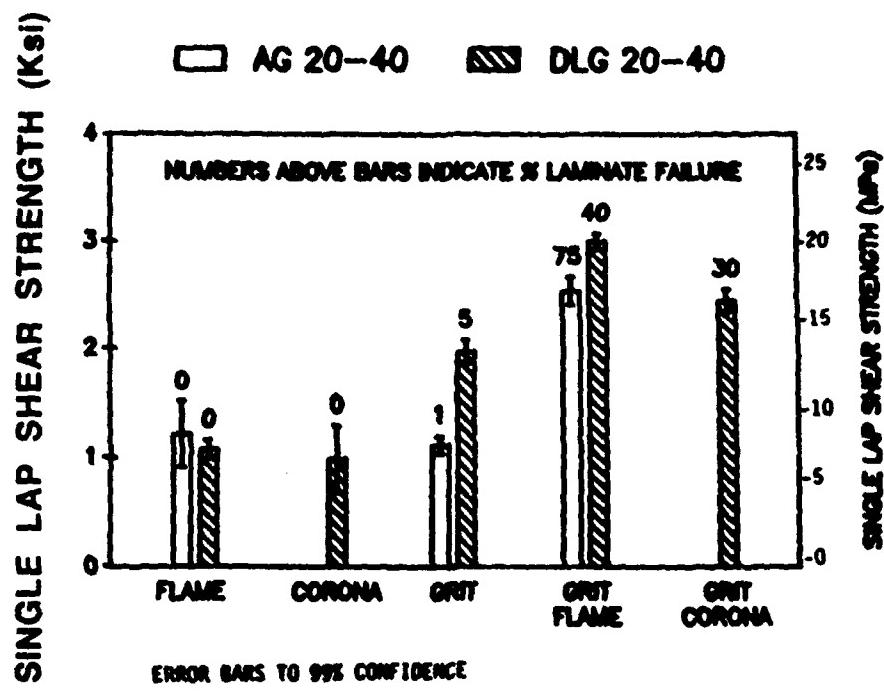
$$L/t \text{ (length of overlap to adherend thickness)} = 7.9$$

Figure 2-38. Single lap shear specimen (ASTM D 1002).

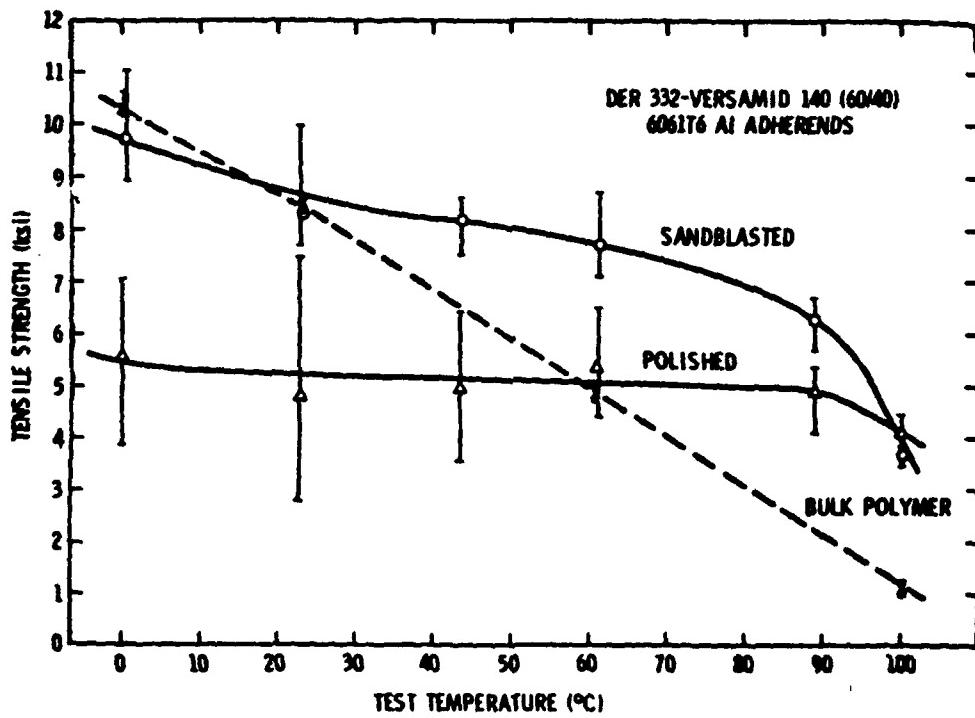
**Surface Preparation.** The importance of surface treatment on the lap shear strength of composites has been studied by a number of engineers, [2-49] through [2-56]. Wu [2-49] showed that the lap shear strength of thermoplastic composites with adhesive FM-300 and a Kevlar peel ply was approximately twice as high as that treated with Corona. Bonazza [2-50] showed that grit blasting followed by flame treatment yields lap shear strength about three times as high as that with the Corona treatment, Figure 2-39. Jennings [2-52] also showed that specimens with a sandblasted surface preparation result in lap shear strengths double those prepared with a polished surface, Figure 2-40.

**Environmental Conditions.** Kerr [2-57] has studied the Uralane X-87174A/B, Epibond X-87152A/B and Epibond A/B using the ASTM D 1002 test method with aluminum adherends. The environmental conditions included elevated temperature, salt spray, fluid immersion in isopropyl alcohol, gasoline and distilled water. Kilbane and McKown [2-58] have investigated the lap shear strength of XC-3700, AF-126-2 and AF-127-3 adhesives with 7075-T6 aluminum adherends. The XC-3700 adhesive is unique in that it is powder form whereas the last two are film adhesives. The authors showed that the lap shear strength of XC-3700 is just slightly less than those of AF-126-2 and AF-127-3. May [2-59] has tested and compared the lap shear strengths of Reliabond 711, American Cynamid FM 123-2, B. F. Goodrich 717 and FR 7030 adhesives per the ASTM D1002 standard. The environmental conditions included fluid exposure in hydraulic oil and jet engine oil, as well as an exfoliation corrosion test. The results show that two of the adhesives, American Cynamid FM 123-2 and FR 7030, have lap shear strengths ranging from 5.1 to 5.5 ksi after immersed the standard finger specimens in MIL-H-5606 hydraulic oil and in MIL-J-5624 jet engine fuel for seven days. These values are only slightly lower than the control shear strengths between 5.2 and 5.5 ksi. Additional testing results due to environmental conditions can be found in Refs. [2-60] through [2-62].

**Moisture Problems.** In 1982, Myhre, Labor and Aker [2-63] addressed the moisture problem in bonded joints of advanced composite structures. The authors compared the lap shear strength of several adhesives under wet and elevated temperature conditions. The loading conditions included static and fatigue. It was found that moisture has significant effects on the lap shear strength of adhesives. For instance, the lap shear strength of FM-73M adhesive at 100° C under dry conditions is two to three times higher than that at a wet



**Figure 2-39.** Effects of surface preparation on single lap shear strength.

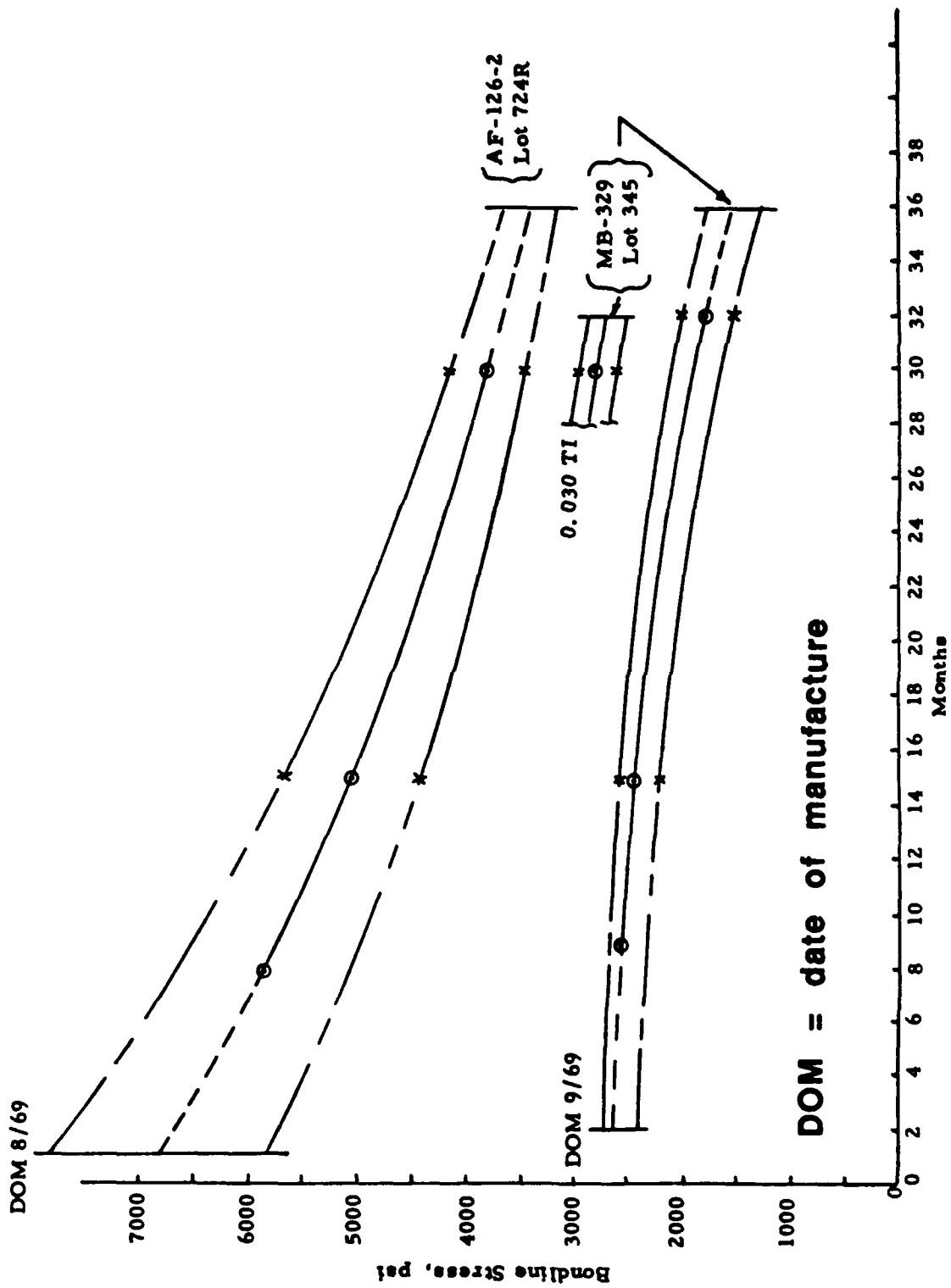


**Figure 2-40.** Effects of surface preparation and temperature on single lap shear strength.

condition. The data presented by Kiger and Myhre [2-64] show that the lap shear strength of the adhesive FM-400 is not affected by moisture at temperatures up to 140° C while it decreases abruptly beyond 50° C for FM-73M [2-63]. This suggests that adhesive FM-400 is moisture resistant. A moisture resistant adhesive is very useful for structural repair because there are many situations in which moisture is difficult to eliminate, especially in the case of damaged composite laminates or damaged honeycomb structures in the field environment. However, FM 400 is a high temperature system not well-adapted to repair. The data in Ref. [2-65] show that the fatigue strength of FM-73M adhesive is slightly lower than EA-9628, and they both decrease tremendously as the moisture content increases. On the other hand, the fatigue strength of 3M adhesive AF-163-2 is only decreased slightly with moisture content up to 70%. Therefore, AF-163-2 is also a moisture resistant adhesive besides FM-400. The T-peel and lap shear strength of FM-73 and FM-300K in the presence of moisture were investigated by Dodiuk et al. [2-66]. The authors found that the T-peel strength values of FM-73 and FM-300K decreased by 27 and 54%, respectively, with 0.6% moisture content by weight. After the moisture was removed by a drying method they proposed (2.5 hours at 3-5 mm Hg vacuum), the room temperature lap shear strength of FM-73 increased by 11-12%. At 105° C, the lap shear strength values of FM-73 and FM-300K increased by 47 and 25%, respectively, after the moisture was removed.

***Cryogenic and Elevated Temperature Applications.*** The adhesive bonding strength of PEEK/IM-6 composites was studied for applications at cryogenic and elevated temperature conditions [2-67]. The screening test was performed using 24 adhesives and 6 different surface preparations. The effect of moisture was also studied. FM 300 and EA 9394 were recommended for cryogenic (-452° F) and elevated temperature (250° F) applications. Although these adhesives have lower bonding strengths than several other adhesives at room temperature, their strengths are not affected by moisture and the degradation in strength at elevated temperature is much less severe than the other adhesives.

***Other Adhesive Lap Shear Properties.*** The effect of storage time on the lap shear strength of adhesives was reported by Grimes [2-68], Figure 2-



**Figure 2-41. Effect of storage life on lap shear strength of AF-126-2 and MB-329 adhesives.**

41, and Tanner [2-56]. Here, the storage time indicates the time after the adhesive was made and before it was used to prepare a bonded joint. The result indicates that the lap shear strength value degrades faster as a function of storage time for AF-126-2 than for MB-329.

Behm and Clark [2-69] have studied two room temperature cured adhesives: CIBA-GEIGY LNH 263-29 and LMH 262-48. These two are toughened epoxy adhesives. They have good toughness and require no special safety handling procedures. The latter has good retention of lap shear strength over a wide temperature range. Its lap shear strength under the environmental conditions of fluid immersion, humidity exposure and thermal aging were also reported. Lap shear strengths of many other adhesives were reported in Refs. [2-69] through [2-74].

Another issue that has been studied is out time (shop life) of adhesives prior to use and the effects on strength of temperature and humidity. After six weeks of open time May [59] reported that the lap shear strength of FR 7030 is as good as its initial value while the American Cyanimid FM 123-2 degrades slightly.

## 2.7. DATABASE

Two computer programs were created using Microsoft "Excel." One, called "Bulk-adhesive," stores adhesive properties as shown in Appendix B-1. Another, "Adhesive Lap-Joints," stores lap shear strength of composites as shown in Appendix B-2. Appendix B-1 and Appendix B-2 contain 23 columns (from A to W) and 16 columns (from A to P), respectively. If one clicks the column number at any column and goes to "sort" under the manual "Data," then he can rank the data in either ascending or descending order.

## 2.8. SUMMARY AND CONCLUSION

Existing adhesive properties and lap shear strengths of composites are collected using the same format. The test methods that were used to generate these data and other commonly used testing methods in this area are discussed with many illustrations. Then the parameters that affect the adhesives and the lap shear properties are discussed.

The adhesive property results include normal stress-strain curve and strength, shear stress-strain curve and strength, the effects of curing temperature, time and cool down rate, creep properties, and thickness effects on the adhesive properties, etc. All the testing methods involve more than one stress component in the test section of the specimen. Therefore, stress analysis must be performed to obtain accurate data interpretation. Apparent experimental results can be misleading without proper data interpretation. For instance, the apparent modulus and strength measured by lap shear tests depend on the thickness of the adherend. This is because the value of stress concentration is different for lap shear tests with different thickness of adherend.

Single and double lap shear configurations have been used extensively in structural applications. Stress analysis has shown that adhesives were subjected to mixed-mode loading of nearly equal magnitude along the bondline. Therefore, these types of bonded joints cannot be used to characterize adhesives. Rather, they should be treated as a quality control test. Parametric studies have shown that surface preparation, environmental conditions, and moisture can change the lap shear strengths tremendously (a few hundred percent).

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## **Chapter 3**

### **Lamina Properties**

Lamina properties are required for analysis of composite structures. The fiber forms in this report include both unidirectional and woven. The elastic properties of particular interest include: longitudinal modulus ( $E_{11}$ ), transverse modulus ( $E_{22}$ ), in-plane shear modulus ( $G_{12}$ ) and major Poisson's ratio ( $\nu_{12}$ ). The strength properties include: longitudinal tensile strength (X), longitudinal compressive strength (X'), transverse tensile strength (Y), transverse compressive strength (Y'), and in-plane shear strength (S).

Again, the data reported here were collected from many journals, technical reports from DoD and national laboratories, and materials manufacturers. These references are listed below. A database was created using "Excel" software and is given in Appendix C-1 ("Lamina Properties").

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## **Chapter 4**

### **Findings/Recommendations**

Several important parameters have been identified for consideration of bolted-joints of composite laminates. The effects of each parameter were elucidated by figures and experimental results. Almost all the experimental data obtained from the literature were for graphite/epoxy and glass/epoxy laminates. Bolted joints data for aramid fibers or organic fibers cannot be found. One additional important point is that almost all the work was geared toward achieving full bearing strength. The efficiency of load-carrying capability of joint-designs has not been studied sufficiently.

For the adhesive study, bulk and bonded forms, cross comparisons between mechanical properties tested by different methods were found to be very limited or deficient. Tensile properties are the easiest to obtain. Dog bone specimens are recommended for evaluating normal properties. For shear properties, confusion exists for moduli values obtained using thick adherend specimens. One group of engineers reported that moduli were linearly proportional to adhesive thickness. This result is highly questionable. More tests and theoretical analysis are needed to confirm this result. The single lap shear test (ASTM D 1002) can be used as a quality control test but should not be used as a tool to determine adhesive properties. The stress distributions for a single lap shear specimen are very complicated. Again, bonded joint specimens with aramid fibers cannot be found in the literature.

**Appendix A-1. Data for single bolted-joints under tensile loading.**



M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Fastener Test	Moisture Content	Falling Load	Bearing Stress	Gross Strength	Gross Strength	Gross Strength	Shear-out Cross Remote Mode					
2	Torque Temperature	(% by Wt)	(% by Wt)	(lb.)	(kN)	(Initial Non-linearity)	(kN)	(P/WI)	(kN)	(kN)	(kN)	(kN)	(kN)
3	in-lb	in-lb	in-lb	in-lb	in-lb	ksi	ksi	ksi	ksi	ksi	ksi	ksi	ksi
4	25	RT	Unknown	2090	Unknown	9.3	Unknown	15.4	15.3	Unknown	16.5	Unknown	16.5
5	25	RT	Unknown	2705	Unknown	11.0	Unknown	18.3	11.7	Unknown	11.2	Unknown	11.2
6	25	RT	Unknown	3220	Unknown	14.2	Unknown	23.5	11.7	Unknown	11.2	Unknown	11.2
7	25	RT	Unknown	3275	Unknown	13.6	Unknown	22.5	11.2	Unknown	11.1	Unknown	11.1
8	25	RT	Unknown	2620	Unknown	11.4	Unknown	18.9	19.1	Unknown	19.1	Unknown	19.1
9	25	RT	Unknown	2500	Unknown	11.0	Unknown	18.2	18.1	Unknown	18.0	Unknown	18.0
10	25	RT	Unknown	3125	Unknown	13.5	Unknown	22.3	11.1	Unknown	10.8	Unknown	10.8
11	25	RT	Unknown	2970	Unknown	13.1	Unknown	21.8	21.6	Unknown	25.6	Unknown	25.2
12	25	RT	Unknown	2200	Unknown	10.2	Unknown	25.2	25.6	Unknown	25.3	Unknown	25.2
13	25	RT	Unknown	2225	Unknown	10.0	Unknown	25.2	25.3	Unknown	25.3	Unknown	25.2
14	25	RT	Unknown	2460	Unknown	11.2	Unknown	27.9	18.3	Unknown	18.3	Unknown	18.3
15	25	RT	Unknown	2570	Unknown	11.5	Unknown	29.1	18.8	Unknown	18.8	Unknown	18.8
16	25	RT	Unknown	2575	Unknown	11.8	Unknown	29.2	14.6	Unknown	14.6	Unknown	14.6
17	25	RT	Unknown	2555	Unknown	11.5	Unknown	28.9	14.3	Unknown	14.3	Unknown	14.3
18	25	RT	Unknown	2335	Unknown	10.2	Unknown	25.2	25.7	Unknown	25.7	Unknown	25.7
19	25	RT	Unknown	2150	Unknown	9.7	Unknown	24.0	24.4	Unknown	24.4	Unknown	24.4
20	25	RT	Unknown	2635	Unknown	11.4	Unknown	28.2	18.3	Unknown	18.3	Unknown	18.3
21	25	RT	Unknown	2845	Unknown	11.8	Unknown	29.6	19.5	Unknown	19.5	Unknown	19.5
22	25	RT	Unknown	2605	Unknown	11.3	Unknown	27.8	13.9	Unknown	13.9	Unknown	13.9
23	25	RT	Unknown	2580	Unknown	11.5	Unknown	28.8	14.4	Unknown	14.4	Unknown	14.4
24	25	RT	Unknown	1695	Unknown	7.4	Unknown	24.5	18.8	Unknown	18.8	Unknown	18.8
25	25	RT	Unknown	1940	Unknown	8.7	Unknown	28.8	22.2	Unknown	22.2	Unknown	22.2
26	25	RT	Unknown	1889	Unknown	8.1	Unknown	27.6	13.4	Unknown	13.4	Unknown	13.4
27	25	RT	Unknown	1930	Unknown	8.5	Unknown	28.1	13.6	Unknown	13.6	Unknown	13.6
28	25	RT	Unknown	1880	Unknown	8.3	Unknown	27.1	10.2	Unknown	10.2	Unknown	10.2
29	25	RT	Unknown	2015	Unknown	8.9	Unknown	29.6	11.1	Unknown	11.1	Unknown	11.1
30	25	RT	Unknown	1893	Unknown	8.5	Unknown	28.0	21.7	Unknown	21.7	Unknown	21.7
31	25	RT	Unknown	2065	Unknown	9.1	Unknown	29.8	23.2	Unknown	23.2	Unknown	23.2
32	25	RT	Unknown	1950	Unknown	8.5	Unknown	27.9	13.5	Unknown	13.5	Unknown	13.5
33	25	RT	Unknown	1930	Unknown	8.5	Unknown	27.9	13.6	Unknown	13.6	Unknown	13.6
34	25	RT	Unknown	2000	Unknown	8.9	Unknown	28.9	10.9	Unknown	10.9	Unknown	10.9
35	25	RT	Unknown	2015	Unknown	8.9	Unknown	29.1	11.0	Unknown	11.0	Unknown	11.0
36	25	RT	Unknown	2485	Unknown	10.9	Unknown	18.2	18.1	Unknown	18.1	Unknown	18.1
37	25	RT	Unknown	2460	Unknown	10.9	Unknown	18.0	17.9	Unknown	17.9	Unknown	17.9
38	25	RT	Unknown	3250	Unknown	14.9	Unknown	24.6	12.2	Unknown	12.2	Unknown	12.2
39	25	RT	Unknown	3270	Unknown	14.9	Unknown	24.7	12.3	Unknown	12.3	Unknown	12.3
40	25	RT	Unknown	2580	Unknown	10.6	Unknown	17.4	17.2	Unknown	17.2	Unknown	17.2
41	25	RT	Unknown	2120	Unknown	8.8	Unknown	14.5	14.5	Unknown	14.5	Unknown	14.5
42	25	RT	Unknown	3040	Unknown	12.4	Unknown	20.6	10.3	Unknown	10.3	Unknown	10.3
43	25	RT	Unknown	3420	Unknown	13.9	Unknown	23.1	11.5	Unknown	11.5	Unknown	11.5
44	25	RT	Unknown	2115	Unknown	9.3	Unknown	22.9	23.1	Unknown	23.1	Unknown	23.1
45	25	RT	Unknown	2175	Unknown	9.7	Unknown	23.7	24.2	Unknown	24.2	Unknown	24.2
46	25	RT	Unknown	2735	Unknown	11.8	Unknown	29.4	19.2	Unknown	19.2	Unknown	19.2
47	25	RT	Unknown	2905	Unknown	12.5	Unknown	31.2	20.2	Unknown	20.2	Unknown	20.2

A	B	C	D	E	F	G	H	I	J	K
48	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.000	0.092	0.251	1.004	3.98	4.00	Double
49	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.004	0.092	0.251	1.003	4.00	4.00	Double
50	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.005	0.091	0.253	0.494	3.97	1.95	Double
51	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.004	0.094	0.253	0.494	3.97	1.95	Double
52	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.002	0.093	0.247	0.760	4.06	3.08	Double
53	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.002	0.092	0.249	0.770	4.02	3.09	Double
54	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.003	0.093	0.252	1.007	3.98	4.00	Double
55	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.004	0.092	0.253	1.006	3.97	3.98	Double
56	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.762	0.091	0.249	0.491	3.06	1.97	Double
57	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.758	0.094	0.249	0.490	3.04	1.97	Double
58	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.760	0.093	0.249	0.778	3.05	3.12	Double
59	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.757	0.090	0.248	0.761	3.07	3.07	Double
60	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.761	0.092	0.252	1.005	3.02	3.99	Double
61	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.758	0.092	0.254	1.007	2.98	3.95	Double
62	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.758	0.092	0.250	0.491	3.03	1.96	Double
63	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.760	0.092	0.251	0.491	3.03	1.96	Double
64	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.757	0.093	0.247	0.776	3.06	3.14	Double
65	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.757	0.093	0.251	0.781	3.02	3.11	Double
66	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.757	0.092	0.252	1.006	3.00	3.99	Double
67	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	0.758	0.093	0.253	1.007	3.00	3.98	Double
68	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.493	0.091	0.251	0.749	5.94	2.98	Double
69	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.491	0.091	0.251	1.513	5.87	5.96	Double
70	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.483	0.0872	0.255	1.514	5.82	5.95	Double
71	T300/N5208	37.5/37.5/25	(045/0/0/45/90/045/45/90/045/45/90/045/)	1.488	0.0886	0.255	0.752	5.84	2.95	Double
72	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.494	0.092	0.250	0.756	5.97	3.02	Double
73	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.493	0.091	0.251	0.749	5.94	5.94	Double
74	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.499	0.192	0.254	1.512	5.91	5.96	Double
75	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.535	0.0888	0.254	0.755	6.05	2.98	Double
76	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.003	0.0923	0.252	0.495	3.98	1.98	Double
77	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.933	0.0928	0.250	0.765	3.98	3.06	Double
78	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.998	0.0926	0.252	1.005	3.96	3.99	Double
79	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.001	0.0916	0.252	1.026	3.97	3.99	Double
80	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.986	0.0908	0.249	0.770	4.00	4.00	Double
81	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.005	0.0925	0.253	0.495	3.97	1.95	Double
82	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.000	0.0929	0.251	0.773	3.98	3.08	Double
83	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.003	0.0913	0.252	0.492	3.99	1.95	Double
84	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.004	0.0937	0.251	0.765	4.00	3.05	Double
85	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.005	0.0938	0.261	1.009	4.00	4.02	Double
86	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	1.002	0.0921	0.251	1.007	4.00	4.02	Double
87	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.762	0.0922	0.253	1.007	3.02	3.99	Double
88	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.757	0.0935	0.253	1.007	2.99	3.98	Double
89	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.754	0.0918	0.246	0.495	3.04	1.95	Double
90	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.763	0.0929	0.246	0.778	3.11	3.16	Double
91	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.762	0.0922	0.253	1.007	3.02	3.99	Double
92	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.757	0.0935	0.253	1.007	2.99	3.98	Double
93	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.754	0.0918	0.246	0.495	3.04	1.95	Double
94	T300/N5208	37.5/30/12.5	(045/0/0/45/90/045/0/45/5	0.760	0.0943	0.251	0.8919	0.251	1.07	Double

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
48	25 RT	Unknown	2775	Unknown	121	Unknown	30.2	15.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
49	25 RT	Unknown	3000	Unknown	131	Unknown	32.5	16.3	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
50	25 RT	Unknown	2200	Unknown	97	Unknown	24.1	24.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
51	25 RT	Unknown	2330	Unknown	99	Unknown	24.7	25.1	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
52	25 RT	Unknown	2770	Unknown	119	Unknown	29.7	19.6	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
53	25 RT	Unknown	2780	Unknown	121	Unknown	29.9	19.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
54	25 RT	Unknown	2810	Unknown	121	Unknown	30.1	15.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
55	25 RT	Unknown	2800	Unknown	122	Unknown	30.3	15.1	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
56	25 RT	Unknown	2210	Unknown	98	Unknown	31.9	24.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
57	25 RT	Unknown	2110	Unknown	90	Unknown	29.6	22.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
58	25 RT	Unknown	2200	Unknown	95	Unknown	31.1	15.2	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
59	25 RT	Unknown	2140	Unknown	95	Unknown	31.4	15.6	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
60	25 RT	Unknown	2185	Unknown	100	Unknown	30.9	11.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
61	25 RT	Unknown	2140	Unknown	94	Unknown	30.7	11.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
62	25 RT	Unknown	2025	Unknown	89	Unknown	29.0	22.4	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
63	25 RT	Unknown	2050	Unknown	89	Unknown	29.3	22.7	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
64	25 RT	Unknown	2150	Unknown	93	Unknown	30.5	14.9	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
65	25 RT	Unknown	2265	Unknown	98	Unknown	32.2	15.6	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
66	25 RT	Unknown	2095	Unknown	91	Unknown	30.1	11.3	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
67	25 RT	Unknown	2225	Unknown	96	Unknown	31.5	11.9	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
68	25 RT	Unknown	2620	Unknown	115	Unknown	19.3	19.2	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
69	25 RT	Unknown	3140	Unknown	137	Unknown	23.0	11.3	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
70	25 RT	Unknown	3000	Unknown	137	Unknown	23.2	11.4	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
71	25 RT	Unknown	2825	Unknown	131	Unknown	21.9	21.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
72	25 RT	Unknown	2820	Unknown	123	Unknown	20.5	20.3	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
73	25 RT	Unknown	2985	Unknown	134	Unknown	22.6	11.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
74	25 RT	Unknown	3185	Unknown	139	Unknown	11.1	5.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
75	25 RT	Unknown	2565	Unknown	114	Unknown	18.6	18.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
76	25 RT	Unknown	2350	Unknown	102	Unknown	25.4	25.7	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
77	25 RT	Unknown	2695	Unknown	116	Unknown	29.2	19.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
78	25 RT	Unknown	2950	Unknown	128	Unknown	31.9	15.8	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
79	25 RT	Unknown	2920	Unknown	128	Unknown	31.8	15.8	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
80	25 RT	Unknown	3015	Unknown	133	Unknown	33.3	21.6	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
81	25 RT	Unknown	2415	Unknown	105	Unknown	26.0	26.4	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
82	25 RT	Unknown	2430	Unknown	104	Unknown	25.8	26.3	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
83	25 RT	Unknown	2565	Unknown	110	Unknown	27.3	17.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
84	25 RT	Unknown	2970	Unknown	127	Unknown	31.5	15.7	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
85	25 RT	Unknown	3340	Unknown	145	Unknown	36.2	18.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
86	25 RT	Unknown	2715	Unknown	117	Unknown	29.2	18.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Gr/EP
87	25 RT	Unknown	2330	Unknown	102	Unknown	25.4	25.8	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
88	25 RT	Unknown	2075	Unknown	91	Unknown	29.8	23.2	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
89	25 RT	Unknown	2350	Unknown	101	Unknown	33.2	18.3	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
90	25 RT	Unknown	2400	Unknown	104	Unknown	34.2	12.9	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
91	25 RT	Unknown	2340	Unknown	101	Unknown	33.2	12.5	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
92	25 RT	Unknown	2605	Unknown	114	Unknown	37.7	18.3	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
93	25 RT	Unknown	2205	Unknown	94	Unknown	30.8	23.9	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP
94	25 RT	Unknown	2230	Unknown	95	Unknown	31.8	24.1	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP

## Single J-Tension

A	B	C	D	E	F	G	H	I	J	K	L
95	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	0.759	0.0923	0.254	0.778	2.99	3.06	Double	0.249 Ti bolt NAS 464-4
96	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	0.756	0.0931	0.253	1.007	2.99	3.98	Double	0.249 Ti bolt NAS 464-4
97	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	0.759	0.0916	0.253	1.007	3.01	3.99	Double	0.249 Ti bolt NAS 464-4
98	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	0.758	0.0921	0.252	0.778	3.01	3.97	Double	0.249 Ti bolt NAS 464-4
99	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	0.759	0.0911	0.250	0.492	3.04	1.97	Double	0.249 Ti bolt NAS 464-4
100	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.501	0.891	0.251	0.720	5.98	2.87	Double	0.249 Ti bolt NAS 464-4
101	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.497	0.089	0.254	1.510	5.89	5.94	Double	0.249 Ti bolt NAS 464-4
102	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.486	0.0904	0.253	1.509	5.87	5.96	Double	0.249 Ti bolt NAS 464-4
103	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.485	0.0894	0.256	0.757	5.80	2.96	Double	0.249 Ti bolt NAS 464-4
104	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.497	0.087	0.252	0.710	5.94	2.82	Double	0.249 Ti bolt NAS 464-4
105	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.483	0.09	0.253	1.499	5.86	5.92	Double	0.249 Ti bolt NAS 464-4
106	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.497	0.0895	0.253	1.503	5.92	5.94	Double	0.249 Ti bolt NAS 464-4
107	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.480	0.089	0.256	0.758	5.78	2.95	Double	0.249 Ti bolt NAS 464-4
108	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.005	0.0908	0.253	0.493	3.97	1.95	Double	0.249 Ti bolt NAS 464-4
109	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.001	0.0897	0.250	0.772	4.00	3.09	Double	0.249 Ti bolt NAS 464-4
110	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.003	0.0903	0.252	1.008	3.98	3.99	Double	0.249 Ti bolt NAS 464-4
111	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.001	0.0892	0.252	1.007	3.97	4.00	Double	0.249 Ti bolt NAS 464-4
112	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.001	0.0898	0.250	0.773	4.00	3.09	Double	0.249 Ti bolt NAS 464-4
113	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.001	0.0886	0.253	0.494	3.96	1.95	Double	0.249 Ti bolt NAS 464-4
114	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.008	0.0899	0.252	0.494	4.03	1.98	Double	0.249 Ti bolt NAS 464-4
115	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.005	0.0904	0.250	0.766	4.00	3.05	Double	0.249 Ti bolt NAS 464-4
116	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.006	0.0902	0.251	1.008	3.99	3.99	Double	0.249 Ti bolt NAS 464-4
117	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.001	0.0889	0.252	1.007	4.05	4.08	Double	0.249 Ti bolt NAS 464-4
118	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.999	0.0886	0.247	0.769	3.95	3.04	Double	0.249 Ti bolt NAS 464-4
119	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	1.003	0.0893	0.253	0.494	4.00	1.97	Double	0.249 Ti bolt NAS 464-4
120	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.755	0.0892	0.251	0.491	3.02	1.96	Double	0.249 Ti bolt NAS 464-4
121	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.755	0.0897	0.250	0.779	2.98	3.08	Double	0.249 Ti bolt NAS 464-4
122	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.755	0.0895	0.253	1.007	2.97	3.96	Double	0.249 Ti bolt NAS 464-4
123	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.762	0.0897	0.254	1.006	3.06	4.04	Double	0.249 Ti bolt NAS 464-4
124	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.759	0.0893	0.249	0.787	3.02	3.14	Double	0.249 Ti bolt NAS 464-4
125	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.764	0.0901	0.251	0.493	3.04	1.96	Double	0.249 Ti bolt NAS 464-4
126	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.763	0.0911	0.251	0.490	3.05	1.96	Double	0.249 Ti bolt NAS 464-4
127	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.760	0.0901	0.250	0.773	3.00	3.08	Double	0.249 Ti bolt NAS 464-4
128	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.761	0.0909	0.253	1.009	2.98	3.98	Double	0.249 Ti bolt NAS 464-4
129	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.766	0.0911	0.255	1.009	3.06	4.04	Double	0.249 Ti bolt NAS 464-4
130	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.766	0.091	0.250	0.787	3.05	3.14	Double	0.249 Ti bolt NAS 464-4
131	Gl/T300/N5208	25/5/0/25	[0/45/90/-45]2s	0.765	0.0911	0.251	0.490	3.05	1.95	Double	0.249 Ti bolt NAS 464-4
132	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.490	0.088	0.251	0.728	5.94	2.80	Double	0.249 Ti bolt NAS 464-4
133	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.493	0.0876	0.254	1.507	5.88	5.93	Double	0.249 Ti bolt NAS 464-4
134	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.500	0.0857	0.255	1.508	5.88	5.91	Double	0.249 Ti bolt NAS 464-4
135	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.508	0.0858	0.256	0.730	5.89	2.85	Double	0.249 Ti bolt NAS 464-4
136	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.497	0.0861	0.251	0.734	5.98	2.92	Double	0.249 Ti bolt NAS 464-4
137	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.494	0.0867	0.255	1.508	5.86	5.91	Double	0.249 Ti bolt NAS 464-4
138	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.501	0.0889	0.253	1.505	5.93	5.95	Double	0.249 Ti bolt NAS 464-4
139	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	1.509	0.0862	0.256	0.750	5.89	2.93	Double	0.249 Ti bolt NAS 464-4
140	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	0.980	0.0882	0.253	0.493	3.91	1.95	Double	0.249 Ti bolt NAS 464-4
141	Gl/T300/N5208	37.5/37.5/25	[0/45/90/-45]0/0/45/-45/0/0/45]0	0.982	0.0889	0.252	0.769	3.90	3.05	Double	0.249 Ti bolt NAS 464-4

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
95	25 RT	Unknown	2530 Unknown	110 Unknown	36.1	17.6	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP		
96	25 RT	Unknown	2370 Unknown	102 Unknown	33.7	12.6	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP		
97	25 RT	Unknown	2600 Unknown	114 Unknown	37.4	14.1	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP		
98	25 RT	Unknown	2470 Unknown	108 Unknown	35.4	17.2	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP		
99	25 RT	Unknown	2345 Unknown	103 Unknown	33.9	26.2	Unknown	Tens	Unknown	Hart-Smith [1-17]	Gr/EP		
100	25 RT	Unknown	2645 Unknown	119 Unknown	2.0	2.1	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
101	25 RT	Unknown	3155 Unknown	142 Unknown	23.7	11.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
102	25 RT	Unknown	3040 Unknown	135 Unknown	22.6	11.1	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
103	25 RT	Unknown	2680 Unknown	120 Unknown	20.2	19.8	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
104	25 RT	Unknown	2330 Unknown	107 Unknown	17.9	18.9	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
105	25 RT	Unknown	3250 Unknown	145 Unknown	24.4	12.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
106	25 RT	Unknown	3035 Unknown	136 Unknown	22.7	11.3	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
107	25 RT	Unknown	2140 Unknown	96 Unknown	16.2	15.9	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
108	25 RT	Unknown	2410 Unknown	107 Unknown	26.4	26.9	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
109	25 RT	Unknown	2830 Unknown	127 Unknown	31.5	20.4	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
110	25 RT	Unknown	2780 Unknown	123 Unknown	30.7	15.3	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
111	25 RT	Unknown	2695 Unknown	121 Unknown	30.2	15.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
112	25 RT	Unknown	2710 Unknown	121 Unknown	30.1	19.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
113	25 RT	Unknown	2230 Unknown	101 Unknown	25.1	25.5	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
114	25 RT	Unknown	2410 Unknown	108 Unknown	26.6	27.1	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
115	25 RT	Unknown	2975 Unknown	132 Unknown	32.7	21.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
116	25 RT	Unknown	2725 Unknown	121 Unknown	30.0	15.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
117	25 RT	Unknown	2700 Unknown	122 Unknown	30.3	15.1	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
118	25 RT	Unknown	2690 Unknown	122 Unknown	30.4	19.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
119	25 RT	Unknown	2310 Unknown	104 Unknown	25.8	26.2	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
120	25 RT	Unknown	2265 Unknown	102 Unknown	33.6	25.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
121	25 RT	Unknown	2355 Unknown	105 Unknown	34.8	16.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
122	25 RT	Unknown	2435 Unknown	109 Unknown	36.0	13.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
123	25 RT	Unknown	2300 Unknown	103 Unknown	33.6	12.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
124	25 RT	Unknown	2360 Unknown	108 Unknown	34.8	16.8	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
125	25 RT	Unknown	2280 Unknown	102 Unknown	33.1	25.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
126	25 RT	Unknown	2250 Unknown	99 Unknown	32.2	25.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
127	25 RT	Unknown	2385 Unknown	105 Unknown	34.5	17.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
128	25 RT	Unknown	2485 Unknown	110 Unknown	35.9	13.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
129	25 RT	Unknown	2505 Unknown	110 Unknown	35.9	13.6	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
130	25 RT	Unknown	2345 Unknown	103 Unknown	33.6	16.4	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
131	25 RT	Unknown	1955 Unknown	86 Unknown	28.1	21.9	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
132	25 RT	Unknown	2380 Unknown	111 Unknown	18.6	19.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
133	25 RT	Unknown	2865 Unknown	131 Unknown	21.9	10.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
134	25 RT	Unknown	2475 Unknown	116 Unknown	19.3	9.6	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
135	25 RT	Unknown	2315 Unknown	108 Unknown	17.9	18.5	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
136	25 RT	Unknown	2475 Unknown	115 Unknown	19.2	19.6	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
137	25 RT	Unknown	2630 Unknown	122 Unknown	20.3	10.1	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
138	25 RT	Unknown	2775 Unknown	129 Unknown	21.5	10.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
139	25 RT	Unknown	2495 Unknown	116 Unknown	19.2	19.3	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
140	25 RT	Unknown	2120 Unknown	97 Unknown	24.3	24.4	Unknown	Sher	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply
141	25 RT	Unknown	2650 Unknown	119 Unknown	30.4	19.4	Unknown	Bear	Unknown	Hart-Smith [1-17]	Hybrid	S-1004	Gr for O-Ply

A	B	C	D	E	F	G	H	I	J	K	L
14.2	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.986	0.0886	0.253	1.010	3.90	3.99	Double	0.249
14.3	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.005	0.0893	0.253	1.007	3.99	4.00	Double	0.249
14.4	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.002	0.0898	0.253	0.768	3.96	3.04	Double	0.249
14.5	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.009	0.0888	0.253	0.486	3.99	1.98	Double	0.249
14.6	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.000	0.0816	0.253	0.495	3.95	1.98	Double	0.249
14.7	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.999	0.0887	0.252	0.767	3.98	3.04	Double	0.249
14.8	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.999	0.0852	0.253	1.008	3.95	3.98	Double	0.249
14.9	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.005	0.0888	0.253	1.008	3.97	3.98	Double	0.249
15.0	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.005	0.0889	0.249	0.771	4.04	3.10	Double	0.249
15.1	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.005	0.0887	0.253	0.493	3.97	1.95	Double	0.249
15.2	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.759	0.0878	0.252	0.492	3.01	1.95	Double	0.249
15.3	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.756	0.0882	0.249	0.764	3.04	3.18	Double	0.249
15.4	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.757	0.0880	0.254	1.007	2.98	3.98	Double	0.249
15.5	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.759	0.0895	0.254	1.009	2.99	3.97	Double	0.249
15.6	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.758	0.0883	0.249	0.776	3.04	3.12	Double	0.249
15.7	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.761	0.0898	0.251	0.491	3.03	1.98	Double	0.249
15.8	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.754	0.0865	0.252	0.493	2.99	1.98	Double	0.249
15.9	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.752	0.0866	0.247	0.779	3.04	3.15	Double	0.249
16.0	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.753	0.0883	0.253	1.004	2.98	3.97	Double	0.249
16.1	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.758	0.0871	0.253	1.006	3.00	3.98	Double	0.249
16.2	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.757	0.0878	0.250	0.773	3.03	3.09	Double	0.249
16.3	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	0.759	0.0864	0.251	0.491	3.02	1.98	Double	0.249
16.4	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.496	0.0872	0.255	0.757	5.86	2.87	Double	0.249
16.5	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.498	0.0871	0.253	1.511	5.92	5.97	Double	0.249
16.6	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.495	0.0873	0.254	1.510	5.89	5.95	Double	0.249
16.7	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.498	0.0855	0.251	0.755	5.97	3.01	Double	0.249
16.8	GI/T300/N5208	37.5/37.5/25	(045/0/-45/90/0/45/-45/0/90/45/0)	1.496	0.0875	0.255	0.747	5.86	2.93	Double	0.249
16.9	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.495	0.0872	0.255	1.510	5.86	5.92	Double	0.249
17.0	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.500	0.0847	0.255	1.511	5.88	5.93	Double	0.249
17.1	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.498	0.0854	0.251	0.742	5.97	2.96	Double	0.249
17.2	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.010	0.0875	0.252	0.492	4.01	1.35	Double	0.249
17.3	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.003	0.082	0.248	0.744	4.04	3.00	Double	0.249
17.4	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.007	0.0848	0.253	1.009	3.98	3.99	Double	0.249
17.5	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.995	0.0861	0.254	1.009	3.92	3.97	Double	0.249
17.6	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.994	0.0875	0.252	0.764	3.94	3.03	Double	0.249
17.7	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.998	0.0847	0.253	0.493	3.94	4.01	Double	0.249
17.8	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.996	0.0886	0.251	0.768	3.97	3.06	Double	0.249
17.9	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.006	0.0885	0.254	0.492	3.96	1.94	Double	0.249
18.0	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.002	0.0865	0.253	0.769	3.96	3.04	Double	0.249
18.1	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	1.004	0.0858	0.252	1.007	3.98	4.09	Double	0.249
18.2	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.998	0.0886	0.252	1.010	3.98	4.01	Double	0.249
18.3	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.996	0.0886	0.251	0.768	3.97	3.06	Double	0.249
18.4	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.999	0.0859	0.253	0.495	3.95	1.98	Double	0.249
18.5	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.759	0.0863	0.252	0.492	3.01	1.95	Double	0.249
18.6	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.758	0.0862	0.245	0.771	3.09	3.15	Double	0.249
18.7	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.760	0.0863	0.254	1.007	2.99	3.96	Double	0.249
18.8	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.760	0.0865	0.254	1.007	2.99	3.96	Double	0.249
18.9	GI/T300/N5208	37.5/30/12.5	(045/0/-45/90/0/45/-45/0/90/45/0)	0.759	0.0852	0.245	0.771	3.05	3.10	Double	0.249

N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
142	25 FT	Unknown	2900	Unknown	131	Unknown	33.2	16.2	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
143	25 FT	Unknown	2715	Unknown	121	Unknown	30.3	15.1	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
144	25 FT	Unknown	2535	Unknown	113	Unknown	28.2	18.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
145	25 FT	Unknown	2110	Unknown	95	Unknown	23.5	24.0	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
146	25 FT	Unknown	2230	Unknown	109	Unknown	27.3	27.6	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
147	25 FT	Unknown	2850	Unknown	129	Unknown	32.2	20.9	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
148	25 FT	Unknown	2605	Unknown	123	Unknown	30.8	15.2	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
149	25 FT	Unknown	2820	Unknown	127	Unknown	31.8	15.8	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
150	25 FT	Unknown	2520	Unknown	113	Unknown	28.2	18.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
151	25 FT	Unknown	2280	Unknown	103	Unknown	25.6	26.1	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
152	25 FT	Unknown	2040	Unknown	93	Unknown	30.6	23.6	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
153	25 FT	Unknown	2435	Unknown	111	Unknown	36.5	17.6	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
154	25 FT	Unknown	2835	Unknown	120	Unknown	39.6	14.9	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
155	25 FT	Unknown	2665	Unknown	119	Unknown	39.2	14.8	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
156	25 FT	Unknown	2480	Unknown	111	Unknown	36.6	17.9	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
157	25 FT	Unknown	2005	Unknown	89	Unknown	29.3	22.7	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
158	25 FT	Unknown	2215	Unknown	103	Unknown	34.0	26.0	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
159	25 FT	Unknown	2540	Unknown	118	Unknown	39.3	19.0	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
160	25 FT	Unknown	2535	Unknown	118	Unknown	39.0	14.6	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
161	25 FT	Unknown	2570	Unknown	118	Unknown	38.9	14.7	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
162	25 FT	Unknown	2635	Unknown	120	Unknown	39.6	19.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
163	25 FT	Unknown	2105	Unknown	98	Unknown	32.1	24.8	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
164	25 FT	Unknown	2425	Unknown	111	Unknown	18.6	18.3	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
165	25 FT	Unknown	2730	Unknown	128	Unknown	20.9	10.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
166	25 FT	Unknown	3005	Unknown	138	Unknown	23.0	11.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
167	25 FT	Unknown	2485	Unknown	116	Unknown	19.4	19.2	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
168	25 FT	Unknown	2225	Unknown	102	Unknown	17.0	17.0	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
169	25 FT	Unknown	3025	Unknown	139	Unknown	23.2	11.5	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
170	25 FT	Unknown	3075	Unknown	146	Unknown	24.2	12.0	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
171	25 FT	Unknown	2515	Unknown	118	Unknown	19.7	19.8	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
172	25 FT	Unknown	2350	Unknown	108	Unknown	26.8	27.3	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
173	25 FT	Unknown	2475	Unknown	121	Unknown	30.1	20.3	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
174	25 FT	Unknown	2495	Unknown	118	Unknown	29.2	14.6	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
175	25 FT	Unknown	2800	Unknown	130	Unknown	32.7	16.1	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
176	25 FT	Unknown	2820	Unknown	129	Unknown	32.4	21.1	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
177	25 FT	Unknown	2265	Unknown	107	Unknown	26.8	27.1	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
178	25 FT	Unknown	2280	Unknown	108	Unknown	26.7	27.3	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
179	25 FT	Unknown	2555	Unknown	118	Unknown	29.5	19.2	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
180	25 FT	Unknown	2355	Unknown	109	Unknown	36.0	27.7	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
181	25 FT	Unknown	2705	Unknown	121	Unknown	31.5	15.6	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
182	25 FT	Unknown	2600	Unknown	121	Unknown	30.4	19.7	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
183	25 FT	Unknown	2310	Unknown	108	Unknown	26.9	27.2	Unknown	Sher	Unknown	Hart-Smith	[1-17] Hybrid.
184	25 FT	Unknown	2710	Unknown	127	Unknown	31.5	15.7	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
185	25 FT	Unknown	2600	Unknown	121	Unknown	39.8	19.6	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
186	25 FT	Unknown	2375	Unknown	110	Unknown	36.2	13.7	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
187	25 FT	Unknown	2590	Unknown	120	Unknown	39.4	14.9	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.
188	25 FT	Unknown	2535	Unknown	119	Unknown	39.2	19.3	Unknown	Bear	Unknown	Hart-Smith	[1-17] Hybrid.

A	B	C	D	E	F	G	H	I	J	K	L	
188	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	0.762	0.0878	0.251	0.491	3.04	1.96	Double	0.249	Ti bolt NAS 464-4
190	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	0.759	0.0835	0.251	0.491	3.02	1.96	Double	0.249	Ti bolt NAS 464-4
191	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	0.756	0.0859	0.250	0.779	3.02	3.12	Double	0.249	Ti bolt NAS 464-4
192	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	0.758	0.0847	0.254	1.007	2.98	3.98	Double	0.249	Ti bolt NAS 464-4
193	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	0.754	0.0866	0.255	1.007	2.96	3.95	Double	0.249	Ti bolt NAS 464-4
194	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	0.753	0.0864	0.249	0.780	3.02	3.13	Double	0.249	Ti bolt NAS 464-4
195	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	0.754	0.0867	0.251	0.490	3.00	1.95	Double	0.249	Ti bolt NAS 464-4
196	T300/N5208	25/50/25	[0/45/90/-45]2S	2.502	0.0903	0.250	0.504	10.01	2.02	Double	0.249	Ti bolt NAS 464-4
197	T300/N5208	25/50/25	[0/45/90/-45]2S	2.495	0.0922	0.250	1.488	9.98	5.95	Double	0.249	Ti bolt NAS 464-4
198	T300/N5208	25/50/25	[0/45/90/-45]2S	2.501	0.0898	0.251	2.003	9.96	7.98	Double	0.249	Ti bolt NAS 464-4
199	T300/N5208	25/50/25	[0/45/90/-45]2S	2.500	0.0895	0.251	1.009	9.99	4.02	Double	0.249	Ti bolt NAS 464-4
200	T300/N5208	25/50/25	[0/45/90/-45]2S	2.504	0.0918	0.250	0.504	10.02	2.02	Double	0.249	Ti bolt NAS 464-4
201	T300/N5208	25/50/25	[0/45/90/-45]2S	2.506	0.0918	0.251	1.487	9.98	5.92	Double	0.249	Ti bolt NAS 464-4
202	T300/N5208	25/50/25	[0/45/90/-45]2S	2.518	0.0907	0.251	2.005	10.03	7.99	Double	0.249	Ti bolt NAS 464-4
203	T300/N5208	25/50/25	[0/45/90/-45]2S	2.501	0.0899	0.251	1.019	9.96	4.08	Double	0.249	Ti bolt NAS 464-4
204	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.504	0.0917	0.250	0.503	1.02	2.01	Double	0.249	Ti bolt NAS 464-4
205	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.498	0.0922	0.250	1.489	9.99	5.96	Double	0.249	Ti bolt NAS 464-4
206	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.499	0.0926	0.251	2.003	9.96	7.98	Double	0.249	Ti bolt NAS 464-4
207	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.508	0.0912	0.251	1.022	9.99	4.07	Double	0.249	Ti bolt NAS 464-4
208	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.508	0.0932	0.251	0.504	1.02	2.01	Double	0.249	Ti bolt NAS 464-4
209	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.506	0.0912	0.250	1.492	10.02	5.97	Double	0.249	Ti bolt NAS 464-4
210	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.507	0.0927	0.251	2.005	9.99	7.99	Double	0.249	Ti bolt NAS 464-4
211	T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.506	0.0938	0.251	0.993	9.98	3.96	Double	0.249	Ti bolt NAS 464-4
212	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.510	0.0914	0.249	0.503	1.08	2.02	Double	0.249	Ti bolt NAS 464-4
213	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.507	0.0918	0.249	1.486	10.07	5.97	Double	0.249	Ti bolt NAS 464-4
214	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.513	0.0903	0.249	2.008	10.09	8.06	Double	0.249	Ti bolt NAS 464-4
215	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.517	0.0913	0.250	1.005	1.07	4.02	Double	0.249	Ti bolt NAS 464-4
216	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.504	0.0881	0.251	0.505	9.98	2.01	Double	0.249	Ti bolt NAS 464-4
217	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.506	0.0899	0.250	1.487	10.02	5.95	Double	0.249	Ti bolt NAS 464-4
218	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.513	0.0902	0.251	2.004	10.01	7.98	Double	0.249	Ti bolt NAS 464-4
219	T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.517	0.09	0.250	1.006	10.07	4.02	Double	0.249	Ti bolt NAS 464-4
220	GI/T300/N5208	25/50/25	[0/45/90/-45]2S	2.507	0.0911	0.249	0.504	1.07	2.02	Double	0.249	Ti bolt NAS 464-4
221	GI/T300/N5208	25/50/25	[0/45/90/-45]2S	2.504	0.0915	0.250	1.491	10.02	5.96	Double	0.249	Ti bolt NAS 464-4
222	GI/T300/N5208	25/50/25	[0/45/90/-45]2S	2.505	0.0911	0.248	2.000	10.10	8.08	Double	0.249	Ti bolt NAS 464-4
223	GI/T300/N5208	25/50/25	[0/45/90/-45]2S	2.507	0.091	0.249	0.993	10.07	3.99	Double	0.249	Ti bolt NAS 464-4
224	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.507	0.0972	0.250	1.487	10.03	5.95	Double	0.249	Ti bolt NAS 464-4
225	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.508	0.0868	0.249	2.002	10.06	8.04	Double	0.249	Ti bolt NAS 464-4
226	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.509	0.0875	0.248	0.998	10.12	4.02	Double	0.249	Ti bolt NAS 464-4
227	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.509	0.087	0.249	0.505	10.08	2.03	Double	0.249	Ti bolt NAS 464-4
228	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.514	0.0885	0.250	1.490	10.14	6.01	Double	0.249	Ti bolt NAS 464-4
229	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.512	0.0883	0.250	2.004	10.09	8.05	Double	0.249	Ti bolt NAS 464-4
230	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.513	0.0879	0.251	0.988	10.05	3.94	Double	0.249	Ti bolt NAS 464-4
231	GI/T300/N5208	37.5/37.5/25	(0/45/90/0/-45/90/0/45/-45/90/0/45/-45/90/0/45)S	2.506	0.0823	0.249	0.509	10.02	2.04	Double	0.249	Ti bolt NAS 464-4
232	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.506	0.0877	0.250	1.491	9.98	5.94	Double	0.249	Ti bolt NAS 464-4
233	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.506	0.0883	0.249	2.002	10.07	8.04	Double	0.249	Ti bolt NAS 464-4
234	GI/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]S	2.502	0.0888	0.257	0.993	10.01	3.97	Double	0.249	Ti bolt NAS 464-4

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
189	25 RT	Unknown	2370	Unknown	108	Unknown	35.4	27.5	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
190	25 RT	Unknown	2240	Unknown	108	Unknown	35.3	27.3	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
191	25 RT	Unknown	2385	Unknown	111	Unknown	36.7	17.8	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
192	25 RT	Unknown	2525	Unknown	119	Unknown	39.3	14.8	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
193	25 RT	Unknown	2475	Unknown	115	Unknown	37.9	14.2	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
194	25 RT	Unknown	2265	Unknown	105	Unknown	34.8	16.8	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
195	25 RT	Unknown	2380	Unknown	110	Unknown	36.4	28.0	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
196	25 RT	Unknown	2450	Unknown	109	Unknown	10.8	26.9	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
197	25 RT	Unknown	2655	Unknown	116	Unknown	11.5	9.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
198	25 RT	Unknown	2660	Unknown	119	Unknown	11.8	7.4	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
199	25 RT	Unknown	2950	Unknown	132	Unknown	13.1	16.3	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
200	25 RT	Unknown	2405	Unknown	105	Unknown	10.5	26.0	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
201	25 RT	Unknown	2890	Unknown	126	Unknown	12.6	10.6	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
202	25 RT	Unknown	2810	Unknown	124	Unknown	12.3	7.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
203	25 RT	Unknown	2920	Unknown	130	Unknown	13.0	15.9	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
204	25 RT	Unknown	2225	Unknown	97	Unknown	9.7	24.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
205	25 RT	Unknown	2415	Unknown	105	Unknown	10.5	8.8	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
206	25 RT	Unknown	2880	Unknown	125	Unknown	12.4	7.8	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
207	25 RT	Unknown	2985	Unknown	131	Unknown	13.1	16.0	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
208	25 RT	Unknown	2310	Unknown	99	Unknown	9.9	24.6	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
209	25 RT	Unknown	3110	Unknown	137	Unknown	13.6	11.4	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
210	25 RT	Unknown	3170	Unknown	137	Unknown	13.6	8.5	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
211	25 RT	Unknown	2830	Unknown	121	Unknown	12.1	15.2	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
212	25 RT	Unknown	2315	Unknown	102	Unknown	10.1	25.2	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
213	25 RT	Unknown	2770	Unknown	121	Unknown	12.0	10.2	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
214	25 RT	Unknown	2850	Unknown	118	Unknown	11.7	7.3	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
215	25 RT	Unknown	2950	Unknown	132	Unknown	13.0	16.3	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
216	25 RT	Unknown	2380	Unknown	109	Unknown	10.8	26.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
217	25 RT	Unknown	2740	Unknown	122	Unknown	12.2	10.2	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
218	25 RT	Unknown	3050	Unknown	136	Unknown	13.5	8.4	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
219	25 RT	Unknown	3020	Unknown	135	Unknown	13.3	16.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Gl/EP	
220	25 RT	Unknown	2300	Unknown	101	Unknown	10.1	25.0	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
221	25 RT	Unknown	2920	Unknown	128	Unknown	12.7	10.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
222	25 RT	Unknown	2860	Unknown	126	Unknown	12.5	7.8	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
223	25 RT	Unknown	2725	Unknown	120	Unknown	11.9	15.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
224	25 RT	Unknown	2115	Unknown	97	Unknown	9.7	24.1	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
225	25 RT	Unknown	2620	Unknown	121	Unknown	12.0	10.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
226	25 RT	Unknown	2825	Unknown	129	Unknown	12.8	8.0	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
227	25 RT	Unknown	2635	Unknown	121	Unknown	12.0	15.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
228	25 RT	Unknown	2170	Unknown	100	Unknown	9.9	24.7	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
229	25 RT	Unknown	2820	Unknown	128	Unknown	12.7	10.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
230	25 RT	Unknown	3090	Unknown	141	Unknown	13.9	8.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
231	25 RT	Unknown	3015	Unknown	138	Unknown	13.8	17.4	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
232	25 RT	Unknown	2285	Unknown	112	Unknown	11.1	27.3	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
233	25 RT	Unknown	2700	Unknown	124	Unknown	12.3	10.3	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
234	25 RT	Unknown	2490	Unknown	116	Unknown	11.5	7.2	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	
235	25 RT	Unknown	2820	Unknown	129	Unknown	12.8	16.1	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid, S-1004 Gl for O-Ply	

A	B	C	D	E	F	G	H	I	J	K	L
236 G/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	2.514	0.0884	0.251	0.505	10.10	2.03	Double	0.249	Ti bolt NAS 464-4
237 G/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	2.512	0.1952	0.249	1.492	9.77	5.81	Double	0.249	Ti bolt NAS 464-4
238 G/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	2.508	0.1952	0.250	2.002	9.99	7.98	Double	0.249	Ti bolt NAS 464-4
239 G/T300/N5208	37.5/50/12.5	[0/45/0/-45/90/45/0/-45]s	2.509	0.0865	0.256	0.990	10.08	3.98	Double	0.249	Ti bolt NAS 464-4
240 T300/N5208	25/50/25	[0/45/90/-45]2s	2.507	0.0808	0.2539	0.494	9.87	1.95	Double	0.249	Pin
241 T300/N5208	25/50/25	[0/45/90/-45]2s	2.514	0.0814	0.2537	1.495	9.91	5.89	Double	0.249	Pin
242 T300/N5208	25/50/25	[0/45/90/-45]2s	2.526	0.0904	0.253	2.003	9.98	7.91	Double	0.249	Pin
243 T300/N5208	25/50/25	[0/45/90/-45]2s	2.536	0.0908	0.253	1.007	10.02	3.98	Double	0.249	Pin
244 T300/N5208	25/50/25	[0/45/90/-45]2s	2.521	0.0907	0.254	0.494	9.92	1.94	Double	0.249	Pin
245 T300/N5208	25/50/25	[0/45/90/-45]2s	2.517	0.0915	0.254	1.489	9.92	5.87	Double	0.249	Pin
246 T300/N5208	25/50/25	[0/45/90/-45]2s	2.516	0.0903	0.253	2.006	9.93	7.92	Double	0.249	Pin
247 T300/N5208	25/50/25	[0/45/90/-45]2s	2.519	0.0909	0.253	1.007	9.98	3.99	Double	0.249	Pin
248 T300/N5208	25/50/25	[0/45/90/-45]2s	0.997	0.1814	0.259	1.016	3.85	3.92	Single	0.249	Ti bolt NAS 464-4
249 T300/N5208	25/50/25	[0/45/90/-45]2s	0.997	0.1807	0.258	1.007	3.86	3.90	Single	0.249	Ti bolt NAS 464-4
250 T300/N5208	25/50/25	[0/45/90/-45]2s	0.997	0.1810	0.259	1.018	3.86	3.95	Single	0.249	Ti bolt NAS 464-4
251 T300/N5208	25/50/25	[0/45/90/-45]2s	0.998	0.1810	0.258	1.014	3.87	3.93	Single	0.249	Ti bolt NAS 464-4
252 M II/N1004	25/50/25	[0/45/90/-45]2s	1.251	0.0943	0.250	0.755	5.00	3.02	Double	0.250	Ti bolt NAS 464-4
253 M II/N1004	25/50/25	[0/45/90/-45]2s	1.237	0.096	0.250	0.760	4.95	3.04	Double	0.250	Ti bolt NAS 464-4
254 M II/N1004	25/50/25	[0/45/90/-45]2s	1.255	0.096	0.250	0.745	5.02	2.98	Double	0.250	Ti bolt NAS 464-4
255 M II/N1004	25/50/25	[0/45/90/-45]2s	1.238	0.0895	0.250	1.005	4.95	4.02	Double	0.250	Ti bolt NAS 464-4
256 M II/N1004	25/50/25	[0/45/90/-45]2s	1.255	0.091	0.250	1.015	5.02	4.06	Double	0.250	Ti bolt NAS 464-4
257 M II/N1004	25/50/25	[0/45/90/-45]2s	1.246	0.0902	0.250	1.010	4.98	4.04	Double	0.250	Ti bolt NAS 464-4
258 M II/N1004	25/50/25	[0/45/90/-45]2s	1.232	0.096	0.250	1.516	4.93	6.06	Double	0.250	Ti bolt NAS 464-4
259 M II/N1004	25/50/25	[0/45/90/-45]2s	1.259	0.098	0.250	1.505	5.04	6.02	Double	0.250	Ti bolt NAS 464-4
260 M II/N1004	25/50/25	[0/45/90/-45]2s	1.248	0.095	0.250	1.510	4.99	6.04	Double	0.250	Ti bolt NAS 464-4
261 M II/N1004	25/50/25	[0/45/90/-45]2s	1.256	0.126	0.250	0.755	5.02	3.02	Double	0.250	Ti bolt NAS 464-4
262 M II/N1004	25/50/25	[0/45/90/-45]2s	1.257	0.127	0.250	0.745	5.03	2.98	Double	0.250	Ti bolt NAS 464-4
263 M II/N1004	25/50/25	[0/45/90/-45]2s	1.250	0.131	0.250	0.755	5.00	3.02	Double	0.250	Ti bolt NAS 464-4
264 M II/N1004	25/50/25	[0/45/90/-45]2s	1.231	0.128	0.250	1.005	4.92	4.02	Double	0.250	Ti bolt NAS 464-4
265 M II/N1004	25/50/25	[0/45/90/-45]2s	1.232	0.129	0.250	0.994	4.93	3.98	Double	0.250	Ti bolt NAS 464-4
266 M II/N1004	25/50/25	[0/45/90/-45]2s	1.256	0.127	0.250	0.995	5.02	3.98	Double	0.250	Ti bolt NAS 464-4
267 M II/N1004	25/50/25	[0/45/90/-45]2s	1.226	0.135	0.250	1.510	4.90	6.04	Double	0.250	Ti bolt NAS 464-4
268 M II/N1004	25/50/25	[0/45/90/-45]2s	1.258	0.136	0.250	1.510	5.03	6.04	Double	0.250	Ti bolt NAS 464-4
269 M II/N1004	25/50/25	[0/45/90/-45]2s	1.258	0.135	0.250	1.506	5.03	6.02	Double	0.250	Ti bolt NAS 464-4
270 M II/N1004	25/50/25	[0/45/90/-45]2s	1.240	0.098	0.190	0.505	6.53	6.66	Double	0.250	Ti bolt NAS 464-4
271 M II/N1004	25/50/25	[0/45/90/-45]2s	1.231	0.0985	0.190	0.506	6.52	2.88	Double	0.250	Ti bolt NAS 464-4
272 M II/N1004	25/50/25	[0/45/90/-45]2s	1.253	0.091	0.190	0.508	6.59	2.86	Double	0.250	Ti bolt NAS 464-4
273 M II/N1004	25/50/25	[0/45/90/-45]2s	1.251	0.089	0.190	0.758	6.58	3.98	Double	0.250	Ti bolt NAS 464-4
274 M II/N1004	25/50/25	[0/45/90/-45]2s	1.232	0.089	0.190	0.756	6.48	3.98	Double	0.250	Ti bolt NAS 464-4
275 M II/N1004	25/50/25	[0/45/90/-45]2s	1.256	0.095	0.192	0.756	6.55	3.94	Double	0.250	Ti bolt NAS 464-4
276 M II/N1004	25/50/25	[0/45/90/-45]2s	1.235	0.0918	0.190	1.280	6.50	6.83	Double	0.250	Ti bolt NAS 464-4
277 M II/N1004	25/50/25	[0/45/90/-45]2s	1.243	0.0895	0.190	1.255	6.54	6.61	Double	0.250	Ti bolt NAS 464-4
278 M II/N1004	25/50/25	[0/45/90/-45]2s	1.257	0.0918	0.190	1.256	6.62	6.61	Double	0.250	Ti bolt NAS 464-4
279 M II/N1004	25/50/25	[0/45/90/-45]2s	1.256	0.0935	0.190	0.500	6.62	2.63	Double	0.250	Ti bolt NAS 464-4
280 M II/N1004	25/50/25	[0/45/90/-45]2s	1.250	0.0933	0.190	0.485	6.58	2.61	Double	0.250	Ti bolt NAS 464-4
281 M II/N1004	25/50/25	[0/45/90/-45]2s	1.259	0.0934	0.190	0.495	6.63	2.61	Double	0.250	Ti bolt NAS 464-4
282 M II/N1004	25/50/25	[0/45/90/-45]2s	1.255	0.0928	0.190	0.190	6.61	4.00	Double	0.250	Ti bolt NAS 464-4

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
236	25 RT	Unknown	2380	Unknown	108	Unknown	10.7	26.7	Unknown	Sher	Unknown	Hart-Smith [1-17] Hybrid	S-1004 Gl for O-Ply
237	25 RT	Unknown	2750	Unknown	129	Unknown	12.8	10.8	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	S-1004 Gl for O-Ply
238	25 RT	Unknown	2720	Unknown	128	Unknown	12.7	8.0	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	S-1004 Gl for O-Ply
239	25 RT	Unknown	2685	Unknown	125	Unknown	12.4	15.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	S-1004 Gl for O-Ply
240	0 RT	Unknown	1530	Unknown	68	Unknown	6.7	17.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	S-1004 Gl for O-Ply
241	0 RT	Unknown	1500	Unknown	66	Unknown	6.5	5.5	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
242	0 RT	Unknown	1345	Unknown	59	Unknown	5.9	3.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
243	0 RT	Unknown	1475	Unknown	65	Unknown	6.4	8.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
244	0 RT	Unknown	1500	Unknown	68	Unknown	6.8	16.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
245	0 RT	Unknown	1105	Unknown	48	Unknown	4.8	4.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
246	0 RT	Unknown	1290	Unknown	57	Unknown	5.7	3.6	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
247	0 RT	Unknown	1460	Unknown	64	Unknown	6.4	8.0	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
248	25 RT	Unknown	4390	Unknown	97	Unknown	24.3	11.9	Unknown	Tens	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
249	25 RT	Unknown	4645	Unknown	103	Unknown	25.8	12.8	Unknown	Tens	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
250	25 RT	Unknown	4480	Unknown	99	Unknown	24.8	12.2	Unknown	Tens	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
251	25 RT	Unknown	4020	Unknown	89	Unknown	22.3	11.0	Unknown	Bear	Unknown	Hart-Smith [1-17] Hybrid	Gr/EP
252	25 RT	Unknown	3462	Unknown	147	Unknown	29.3	24.3	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
253	25 RT	Unknown	3269	Unknown	136	Unknown	27.5	22.4	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
254	25 RT	Unknown	2788	Unknown	117	Unknown	23.4	19.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
255	25 RT	Unknown	3499	Unknown	156	Unknown	31.8	19.5	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
256	25 RT	Unknown	3340	Unknown	147	Unknown	29.2	18.1	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
257	25 RT	Unknown	3185	Unknown	141	Unknown	28.3	17.5	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
258	25 RT	Unknown	3509	Unknown	146	Unknown	29.7	12.1	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
259	25 RT	Unknown	3809	Unknown	156	Unknown	30.9	12.9	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
260	25 RT	Unknown	3870	Unknown	163	Unknown	32.6	13.5	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
261	25 RT	Unknown	4135	Unknown	131	Unknown	26.1	21.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
262	25 RT	Unknown	4752	Unknown	149	Unknown	29.8	25.1	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
263	25 RT	Unknown	4520	Unknown	138	Unknown	27.6	22.9	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
264	25 RT	Unknown	5168	Unknown	162	Unknown	32.8	20.1	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
265	25 RT	Unknown	4942	Unknown	153	Unknown	31.1	19.3	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
266	25 RT	Unknown	4851	Unknown	153	Unknown	30.4	19.2	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
267	25 RT	Unknown	5142	Unknown	152	Unknown	31.1	12.6	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
268	25 RT	Unknown	4785	Unknown	141	Unknown	28.0	11.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
269	25 RT	Unknown	4980	Unknown	147	Unknown	29.2	12.2	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
270	25 RT	Unknown	2449	Unknown	132	Unknown	20.2	24.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
271	25 RT	Unknown	2320	Unknown	127	Unknown	19.4	23.8	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
272	25 RT	Unknown	2357	Unknown	136	Unknown	20.7	25.6	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
273	25 RT	Unknown	2790	Unknown	165	Unknown	25.1	20.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
274	25 RT	Unknown	2500	Unknown	148	Unknown	22.8	18.6	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
275	25 RT	Unknown	2837	Unknown	157	Unknown	23.7	19.8	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
276	25 RT	Unknown	2935	Unknown	168	Unknown	25.9	12.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
277	25 RT	Unknown	2995	Unknown	176	Unknown	26.9	13.3	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
278	25 RT	Unknown	2995	Unknown	172	Unknown	26.0	13.0	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
279	25 RT	Unknown	3470	Unknown	135	Unknown	204.3	257.0	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
280	25 RT	Unknown	3800	Unknown	150	Unknown	226.6	286.6	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
281	25 RT	Unknown	3781	Unknown	149	Unknown	224.1	285.0	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP
282	25 RT	Unknown	4111	Unknown	169	Unknown	255.7	211.3	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite II	Gr/EP

	A	B	C	D	E	F	G	H	I	J	K	L
283 M	II/N1004	25/50/25	(0/45/90/-45)25	1.257	0.0132	0.190	0.755	6.62	3.97	Double	0.250	T1 bolt NAS 464-4
284 M	II/N1004	25/50/25	(0/45/90/-45)25	1.256	0.0129	0.190	0.755	6.61	3.97	Double	0.250	T1 bolt NAS 464-4
285 M	II/N1004	25/50/25	(0/45/90/-45)25	1.257	0.0129	0.191	1.256	6.58	6.58	Double	0.250	T1 bolt NAS 464-4
286 M	II/N1004	25/50/25	(0/45/90/-45)25	1.257	0.0126	0.190	1.255	6.62	6.61	Double	0.250	T1 bolt NAS 464-4
287 M	II/N1004	25/50/25	(0/45/90/-45)25	1.251	0.0131	0.190	1.260	6.58	6.63	Double	0.250	T1 bolt NAS 464-4
288 M	II/N1004	50/50/0	Unknown	1.247	0.091	0.254	0.750	4.91	2.95	Double	0.250	T1 bolt NAS 464-4
289 M	II/N1004	50/50/0	Unknown	1.245	0.09	0.253	0.750	4.92	2.96	Double	0.250	T1 bolt NAS 464-4
290 M	II/N1004	50/50/0	Unknown	1.240	0.091	0.254	0.750	4.88	2.95	Double	0.250	T1 bolt NAS 464-4
291 M	II/N1004	50/50/0	Unknown	1.241	0.089	0.254	1.016	4.89	4.00	Double	0.250	T1 bolt NAS 464-4
292 M	II/N1004	50/50/0	Unknown	1.245	0.091	0.253	1.016	4.92	4.02	Double	0.250	T1 bolt NAS 464-4
293 M	II/N1004	50/50/0	Unknown	1.249	0.09	0.254	1.000	4.92	3.94	Double	0.250	T1 bolt NAS 464-4
294 M	II/N1004	50/50/0	Unknown	1.259	0.091	0.254	1.516	4.96	5.97	Double	0.250	T1 bolt NAS 464-4
295 M	II/N1004	50/50/0	Unknown	1.262	0.093	0.253	1.516	4.99	5.99	Double	0.250	T1 bolt NAS 464-4
296 M	II/N1004	50/50/0	Unknown	1.255	0.091	0.253	1.516	4.96	2.98	Double	0.250	T1 bolt NAS 464-4
297 M	II/N1004	50/50/0	Unknown	1.253	0.131	0.254	0.754	4.93	2.98	Double	0.250	T1 bolt NAS 464-4
298 M	II/N1004	50/50/0	Unknown	1.253	0.132	0.254	0.756	4.93	2.97	Double	0.250	T1 bolt NAS 464-4
299 M	II/N1004	50/50/0	Unknown	1.258	0.129	0.253	0.755	4.97	3.98	Double	0.250	T1 bolt NAS 464-4
300 M	II/N1004	50/50/0	Unknown	1.253	0.126	0.253	1.006	4.95	3.98	Double	0.250	T1 bolt NAS 464-4
301 M	II/N1004	50/50/0	Unknown	1.253	0.128	0.254	1.008	4.93	3.94	Double	0.250	T1 bolt NAS 464-4
302 M	II/N1004	50/50/0	Unknown	1.253	0.124	0.254	1.002	4.93	5.92	Double	0.250	T1 bolt NAS 464-4
303 M	II/N1004	50/50/0	Unknown	1.252	0.128	0.254	1.504	4.93	5.93	Double	0.250	T1 bolt NAS 464-4
304 M	II/N1004	50/50/0	Unknown	1.252	0.128	0.254	1.507	4.93	5.93	Double	0.250	T1 bolt NAS 464-4
305 M	II/N1004	50/50/0	Unknown	1.252	0.126	0.254	1.505	4.93	5.93	Double	0.250	T1 bolt NAS 464-4
306 M	II/N1004	50/50/0	Unknown	1.244	0.092	0.180	0.515	6.55	2.71	Double	0.250	T1 bolt NAS 464-4
307 M	II/N1004	50/50/0	Unknown	1.242	0.094	0.193	0.500	6.44	2.59	Double	0.250	T1 bolt NAS 464-4
308 M	II/N1004	50/50/0	Unknown	1.250	0.094	0.192	0.500	6.51	2.60	Double	0.250	T1 bolt NAS 464-4
309 M	II/N1004	50/50/0	Unknown	1.245	0.092	0.190	0.735	6.55	3.87	Double	0.250	T1 bolt NAS 464-4
310 M	II/N1004	50/50/0	Unknown	1.243	0.094	0.191	0.766	6.51	4.01	Double	0.250	T1 bolt NAS 464-4
311 M	II/N1004	50/50/0	Unknown	1.248	0.093	0.190	0.766	6.57	4.03	Double	0.250	T1 bolt NAS 464-4
312 M	II/N1004	50/50/0	Unknown	1.255	0.092	0.190	1.281	6.61	6.74	Double	0.250	T1 bolt NAS 464-4
313 M	II/N1004	50/50/0	Unknown	1.256	0.081	0.190	1.281	6.61	6.74	Double	0.250	T1 bolt NAS 464-4
314 M	II/N1004	50/50/0	Unknown	1.267	0.091	0.190	1.286	6.67	6.86	Double	0.250	T1 bolt NAS 464-4
315 M	II/N1004	50/50/0	Unknown	1.252	0.124	0.190	0.499	6.59	2.63	Double	0.250	T1 bolt NAS 464-4
316 M	II/N1004	50/50/0	Unknown	1.252	0.128	0.180	0.503	6.59	2.65	Double	0.250	T1 bolt NAS 464-4
317 M	II/N1004	50/50/0	Unknown	1.252	0.125	0.190	0.504	6.59	2.85	Double	0.250	T1 bolt NAS 464-4
318 M	II/N1004	50/50/0	Unknown	1.252	0.125	0.190	0.757	6.59	3.98	Double	0.250	T1 bolt NAS 464-4
319 M	II/N1004	50/50/0	Unknown	1.253	0.124	0.190	0.755	6.59	3.95	Double	0.250	T1 bolt NAS 464-4
320 M	II/N1004	50/50/0	Unknown	1.253	0.124	0.190	0.755	6.59	3.97	Double	0.250	T1 bolt NAS 464-4
321 M	II/N1004	50/50/0	Unknown	1.259	0.132	0.190	1.259	6.63	6.83	Double	0.250	T1 bolt NAS 464-4
322 M	II/N1004	50/50/0	Unknown	1.254	0.133	0.190	1.254	6.60	6.90	Double	0.250	T1 bolt NAS 464-4
323 M	II/N1004	50/50/0	Unknown	1.253	0.131	0.190	1.262	6.59	6.84	Double	0.250	T1 bolt NAS 464-4
324 M	II/N1004	25/75/0	Unknown	2.520	0.175	0.250	0.512	10.08	2.05	Double	0.250	T1 bolt NAS 464-4
325 M	II/N1004	25/75/0	Unknown	2.521	0.173	0.250	0.508	10.08	2.03	Double	0.250	T1 bolt NAS 464-4
326 M	II/N1004	25/75/0	Unknown	2.520	0.175	0.250	1.493	10.08	5.97	Double	0.250	T1 bolt NAS 464-4
327 M	II/N1004	25/75/0	Unknown	2.521	0.173	0.250	1.490	10.08	5.96	Double	0.250	T1 bolt NAS 464-4
328 M	II/N1004	25/75/0	Unknown	2.499	0.17	0.250	0.515	10.00	2.06	Double	0.250	T1 bolt NAS 464-4
329 M	II/N1004	25/75/0	Unknown	2.494	0.175	0.250	0.512	9.98	2.05	Double	0.250	T1 bolt NAS 464-4

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
283	25	RT	Unknown	3745	Unknown	149	Unknown	225.7	187.9	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
284	25	RT	Unknown	3825	Unknown	156	Unknown	236.1	196.4	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
285	25	RT	Unknown	4222	Unknown	172	Unknown	260.4	130.3	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
286	25	RT	Unknown	4000	Unknown	167	Unknown	252.6	126.5	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
287	25	RT	Unknown	4595	Unknown	185	Unknown	280.4	139.2	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
288	25	RT	Unknown	3205	Unknown	141	Unknown	28.2	23.5	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
289	25	RT	Unknown	2915	Unknown	129	Unknown	26.0	21.6	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
290	25	RT	Unknown	3102	Unknown	136	Unknown	27.5	22.7	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
291	25	RT	Unknown	3319	Unknown	149	Unknown	30.1	16.4	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
292	25	RT	Unknown	3571	Unknown	157	Unknown	31.5	19.3	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
293	25	RT	Unknown	3440	Unknown	153	Unknown	30.6	19.1	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
294	25	RT	Unknown	3340	Unknown	147	Unknown	29.2	12.1	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
295	25	RT	Unknown	3536	Unknown	152	Unknown	30.1	12.5	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
296	25	RT	Unknown	3465	Unknown	152	Unknown	30.3	12.6	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
297	25	RT	Unknown	3800	Unknown	116	Unknown	23.2	19.2	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
298	25	RT	Unknown	3755	Unknown	114	Unknown	22.7	18.8	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
299	25	RT	Unknown	4365	Unknown	135	Unknown	26.9	22.4	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
300	25	RT	Unknown	4735	Unknown	150	Unknown	30.0	18.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
301	25	RT	Unknown	4755	Unknown	151	Unknown	30.1	18.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
302	25	RT	Unknown	4175	Unknown	135	Unknown	26.9	16.8	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
303	25	RT	Unknown	4380	Unknown	139	Unknown	27.8	11.6	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
304	25	RT	Unknown	4450	Unknown	139	Unknown	27.8	11.5	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
305	25	RT	Unknown	4920	Unknown	153	Unknown	30.6	12.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
306	25	RT	Unknown	2098	Unknown	120	Unknown	18.3	22.1	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
307	25	RT	Unknown	2080	Unknown	114	Unknown	17.8	22.1	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
308	25	RT	Unknown	2068	Unknown	116	Unknown	17.6	22.0	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
309	25	RT	Unknown	2450	Unknown	140	Unknown	21.4	18.1	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
310	25	RT	Unknown	2429	Unknown	136	Unknown	20.8	16.9	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
311	25	RT	Unknown	2310	Unknown	131	Unknown	19.9	16.2	Unknown	Sher	Unknown	Hart-Smith [1-17] Fiber: Morganite I
312	25	RT	Unknown	2665	Unknown	153	Unknown	23.1	11.3	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
313	25	RT	Unknown	2523	Unknown	146	Unknown	22.1	10.9	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
314	25	RT	Unknown	2542	Unknown	147	Unknown	22.0	11.0	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
315	25	RT	Unknown	2895	Unknown	123	Unknown	18.6	23.4	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
316	25	RT	Unknown	3040	Unknown	125	Unknown	19.0	23.6	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
317	25	RT	Unknown	2787	Unknown	117	Unknown	17.8	22.1	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
318	25	RT	Unknown	3755	Unknown	158	Unknown	24.0	19.8	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
319	25	RT	Unknown	3515	Unknown	147	Unknown	22.3	18.6	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
320	25	RT	Unknown	3262	Unknown	139	Unknown	21.0	17.4	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
321	25	RT	Unknown	3996	Unknown	159	Unknown	24.0	12.0	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
322	25	RT	Unknown	4015	Unknown	159	Unknown	24.1	12.0	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
323	25	RT	Unknown	3860	Unknown	155	Unknown	23.5	11.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
324	25	RT	Unknown	4070	Unknown	93	Unknown	9.2	22.7	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
325	25	RT	Unknown	3420	Unknown	79	Unknown	7.8	19.5	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
326	25	RT	Unknown	6660	Unknown	152	Unknown	15.1	12.7	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
327	25	RT	Unknown	6420	Unknown	148	Unknown	14.7	12.5	Unknown	Bear	Unknown	Hart-Smith [1-17] Fiber: Morganite I
328	25	RT	Unknown	3370	Unknown	79	Unknown	7.9	19.2	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I
329	25	RT	Unknown	4140	Unknown	95	Unknown	9.5	23.1	Unknown	Tens	Unknown	Hart-Smith [1-17] Fiber: Morganite I

## Single J-Tension

A	B	C	D	E	F	G	H	I	J	K	L
320 M I/N1004	25/75/0	Unknown	2.499	0.17	0.250	1.494	10.00	5.98	Double	0.250	Ti bolt NAS 464-4
321 M I/N1004	25/75/0	Unknown	2.494	0.175	0.250	1.493	9.98	5.97	Double	0.250	Ti bolt NAS 464-4
322 M I/N1004	50/50/0	Unknown	2.498	0.177	0.250	0.511	9.99	2.04	Double	0.250	Ti bolt NAS 464-4
323 M I/N1004	50/50/0	Unknown	2.500	0.178	0.250	0.504	10.00	2.02	Double	0.250	Ti bolt NAS 464-4
324 M I/N1004	50/50/0	Unknown	2.498	0.177	0.250	1.868	9.99	7.47	Double	0.250	Ti bolt NAS 464-4
325 M I/N1004	50/50/0	Unknown	2.500	0.178	0.250	1.868	10.00	7.47	Double	0.250	Ti bolt NAS 464-4
326 M I/N1004	50/50/0	Unknown	2.476	0.175	0.250	0.503	9.90	2.01	Double	0.250	Ti bolt NAS 464-4
327 M I/N1004	50/50/0	Unknown	2.506	0.176	0.250	0.499	10.02	2.00	Double	0.250	Ti bolt NAS 464-4
328 M I/N1004	50/50/0	Unknown	2.476	0.176	0.250	1.867	9.90	7.47	Double	0.250	Ti bolt NAS 464-4
329 M I/N1004	50/50/0	Unknown	2.506	0.176	0.250	1.867	10.02	7.47	Double	0.250	Ti bolt NAS 464-4
340 M I/N1004	75/25/0	Unknown	1.996	0.172	0.250	0.490	7.98	1.96	Double	0.250	Ti bolt NAS 464-4
341 M I/N1004	75/25/0	Unknown	1.999	0.173	0.250	0.505	8.00	2.02	Double	0.250	Ti bolt NAS 464-4
342 M I/N1004	75/25/0	Unknown	1.996	0.172	0.250	2.368	7.98	9.46	Double	0.250	Ti bolt NAS 464-4
343 M I/N1004	75/25/0	Unknown	1.999	0.173	0.250	2.367	9.00	9.47	Double	0.250	Ti bolt NAS 464-4
344 M I/N1004	75/25/0	Unknown	2.002	0.173	0.250	0.501	8.01	2.00	Double	0.250	Ti bolt NAS 464-4
345 M I/N1004	75/25/0	Unknown	1.995	0.177	0.250	0.510	7.98	2.04	Double	0.250	Ti bolt NAS 464-4
346 M I/N1004	75/25/0	Unknown	2.002	0.173	0.250	2.366	8.01	9.46	Double	0.250	Ti bolt NAS 464-4
347 M I/N1004	75/25/0	Unknown	1.965	0.177	0.250	2.364	7.98	9.46	Double	0.250	Ti bolt NAS 464-4
348 M I/N1004	25/62.5/12.5	Unknown	2.496	0.174	0.250	0.513	9.93	2.08	Double	0.250	Ti bolt NAS 464-4
349 M I/N1004	25/62.5/12.5	Unknown	2.93	0.174	0.250	0.505	9.86	2.02	Double	0.250	Ti bolt NAS 464-4
350 M I/N1004	25/62.5/12.5	Unknown	2.496	0.174	0.250	1.367	9.38	7.47	Double	0.250	Ti bolt NAS 464-4
351 M I/N1004	25/62.5/12.5	Unknown	2.497	0.174	0.250	1.358	9.39	7.47	Double	0.250	Ti bolt NAS 464-4
352 M I/N1004	25/62.5/12.5	Unknown	2.495	0.177	0.250	0.300	9.95	2.00	Double	0.250	Ti bolt NAS 464-4
353 M I/N1004	25/62.5/12.5	Unknown	2.491	0.176	0.250	0.521	9.53	2.08	Double	0.250	Ti bolt NAS 464-4
354 M I/N1004	25/62.5/12.5	Unknown	2.495	0.177	0.250	1.866	9.99	7.46	Double	0.250	Ti bolt NAS 464-4
355 M I/N1004	25/62.5/12.5	Unknown	2.49	0.176	0.250	1.930	9.96	7.45	Double	0.250	Ti bolt NAS 464-4
356 M I/N1004	50/37.5/12.5	Unknown	2.485	0.176	0.250	0.337	9.94	2.06	Double	0.250	Ti bolt NAS 464-4
357 M I/N1004	50/37.5/12.5	Unknown	2.484	0.176	0.250	0.337	9.94	2.15	Double	0.250	Ti bolt NAS 464-4
358 M I/N1004	50/37.5/12.5	Unknown	2.485	0.176	0.250	1.866	9.94	7.46	Double	0.250	Ti bolt NAS 464-4
359 M I/N1004	50/37.5/12.5	Unknown	2.484	0.178	0.250	1.967	9.94	7.47	Double	0.250	Ti bolt NAS 464-4
360 M I/N1004	50/37.5/12.5	Unknown	2.502	0.178	0.250	0.734	10.01	2.02	Double	0.250	Ti bolt NAS 464-4
361 M I/N1004	50/37.5/12.5	Unknown	2.608	0.176	0.250	0.491	10.33	1.96	Double	0.250	Ti bolt NAS 464-4
362 M I/N1004	50/37.5/12.5	Unknown	1.52	0.176	0.250	1.866	10.01	7.46	Double	0.250	Ti bolt NAS 464-4
363 M I/N1004	50/37.5/12.5	Unknown	1.501	0.179	0.250	1.867	10.03	7.47	Double	0.250	Ti bolt NAS 464-4
364 M I/N1004	75/12.5/12.5	Unknown	2.002	0.178	0.250	0.492	8.01	.97	Double	0.250	Ti bolt NAS 464-4
365 M I/N1004	75/12.5/12.5	Unknown	1.944	0.177	0.250	1.485	7.98	1.94	Double	0.250	Ti bolt NAS 464-4
366 M I/N1004	75/12.5/12.5	Unknown	2.002	0.178	0.250	2.365	8.01	9.48	Double	0.250	Ti bolt NAS 464-4
367 M I/N1004	75/12.5/12.5	Unknown	1.94	0.178	0.250	2.366	7.98	9.46	Double	0.250	Ti bolt NAS 464-4
368 M I/N1004	75/12.5/12.5	Unknown	2.001	0.177	0.250	0.490	8.03	1.96	Double	0.250	Ti bolt NAS 464-4
369 M I/N1004	75/12.5/12.5	Unknown	1.997	0.178	0.250	0.474	7.99	1.80	Double	0.250	Ti bolt NAS 464-4
370 M I/N1004	75/12.5/12.5	Unknown	2.001	0.177	0.250	2.367	9.00	9.47	Double	0.250	Ti bolt NAS 464-4
371 M I/N1004	75/12.5/12.5	Unknown	1.997	0.178	0.250	2.366	7.99	9.48	Double	0.250	Ti bolt NAS 464-4
372 M I/N1004	25/50/25	Unknown	2.502	0.172	0.250	0.501	10.01	2.01	Double	0.250	Ti bolt NAS 464-4
373 M I/N1004	25/50/25	Unknown	2.500	0.171	0.250	0.501	10.01	2.02	Double	0.250	Ti bolt NAS 464-4
374 M I/N1004	25/50/25	Unknown	2.502	0.171	0.250	1.867	10.01	7.47	Double	0.250	Ti bolt NAS 464-4
375 M I/N1004	25/50/25	Unknown	2.500	0.171	0.250	1.865	10.00	7.46	Double	0.250	Ti bolt NAS 464-4
376 M I/N1004	25/50/25	Unknown	2.493	0.172	0.250	0.49	9.97	2.00	Double	0.250	Ti bolt NAS 464-4

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
330	25	Pa	Unknown	6450	Unknown	152	Unknown	15.2	12.7	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite	
331	25	Pa	Unknown	5720	Unknown	131	Unknown	13.1	10.9	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite	
332	25	Pa	Unknown	3410	Unknown	77	Unknown	7.7	18.9	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
333	25	Pa	Unknown	3705	Unknown	83	Unknown	8.3	20.6	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
334	25	Pa	Unknown	6080	Unknown	137	Unknown	13.8	9.2	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
335	25	Pa	Unknown	5990	Unknown	135	Unknown	13.5	9.0	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
336	25	Pa	Unknown	3160	Unknown	72	Unknown	7.3	17.9	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
337	25	Pa	Unknown	3060	Unknown	69	Unknown	6.9	17.4	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
338	25	Pa	Unknown	6520	Unknown	149	Unknown	15.0	10.0	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
339	25	Pa	Unknown	6330	Unknown	144	Unknown	14.4	9.6	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
340	25	Pa	Unknown	1815	Unknown	42	Unknown	5.3	10.8	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
341	25	Pa	Unknown	2180	Unknown	50	Unknown	6.3	12.5	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
342	25	Pa	Unknown	5540	Unknown	129	Unknown	16.1	6.9	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
343	25	Pa	Unknown	5640	Unknown	130	Unknown	16.3	6.9	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
344	25	Pa	Unknown	1920	Unknown	44	Unknown	5.5	11.1	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
345	25	Pa	Unknown	2385	Unknown	54	Unknown	6.8	13.2	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
346	25	Pa	Unknown	5370	Unknown	124	Unknown	15.5	6.6	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
347	25	Pa	Unknown	5230	Unknown	118	Unknown	14.8	6.2	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
348	25	Pa	Unknown	4160	Unknown	96	Unknown	9.6	23.0	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
349	25	Pa	Unknown	4470	Unknown	103	Unknown	10.3	25.4	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
350	25	Pa	Unknown	6460	Unknown	149	Unknown	14.9	9.9	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
351	25	Pa	Unknown	6230	Unknown	143	Unknown	14.3	9.6	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
352	25	Pa	Unknown	3990	Unknown	90	Unknown	9.0	22.5	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
353	25	Pa	Unknown	4555	Unknown	104	Unknown	10.4	24.8	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
354	25	Pa	Unknown	6520	Unknown	147	Unknown	14.8	9.9	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
355	25	Pa	Unknown	5570	Unknown	127	Unknown	12.7	8.5	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
356	25	Pa	Unknown	3020	Unknown	69	Unknown	6.9	16.7	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
357	25	Pa	Unknown	3220	Unknown	73	Unknown	7.4	17.0	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
358	25	Pa	Unknown	6750	Unknown	153	Unknown	15.4	10.3	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
359	25	Pa	Unknown	6177	Unknown	140	Unknown	14.1	9.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
360	25	Pa	Unknown	3260	Unknown	74	Unknown	7.4	18.4	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
361	25	Pa	Unknown	3230	Unknown	73	Unknown	7.3	18.7	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
362	25	Pa	Unknown	6240	Unknown	142	Unknown	14.2	9.5	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
363	25	Pa	Unknown	6200	Unknown	141	Unknown	14.0	9.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
364	25	Pa	Unknown	2015	Unknown	45	Unknown	5.7	11.5	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
365	25	Pa	Unknown	1965	Unknown	44	Unknown	5.5	11.4	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
366	25	Pa	Unknown	5720	Unknown	129	Unknown	16.1	6.8	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
367	25	Pa	Unknown	5970	Unknown	134	Unknown	16.8	7.1	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
368	25	Pa	Unknown	1650	Unknown	37	Unknown	4.7	9.5	Unknown	Sher	Unknown	Hart-Smith	[1-17] Fiber: Morganite
369	25	Pa	Unknown	1840	Unknown	41	Unknown	5.2	10.9	Unknown	Clev	Unknown	Hart-Smith	[1-17] Fiber: Morganite
370	25	Pa	Unknown	5450	Unknown	123	Unknown	15.4	6.5	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
371	25	Pa	Unknown	6170	Unknown	139	Unknown	17.4	7.3	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
372	25	Pa	Unknown	3210	Unknown	75	Unknown	7.5	18.6	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
373	25	Pa	Unknown	3600	Unknown	84	Unknown	8.4	20.8	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite
374	25	Pa	Unknown	6030	Unknown	140	Unknown	14.0	9.4	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
375	25	Pa	Unknown	6570	Unknown	154	Unknown	15.4	10.3	Unknown	Bear	Unknown	Hart-Smith	[1-17] Fiber: Morganite
376	25	Pa	Unknown	3680	Unknown	86	Unknown	8.6	21.4	Unknown	Tens	Unknown	Hart-Smith	[1-17] Fiber: Morganite

A	B	C	D	E	F	G	H	I	J	K	L
377 M I/N1004	25/50/25	Unknown	2.497	0.171	0.250	1.866	9.99	7.46	Double	0.250	Ti bolt NAS 464-4
378 M I/N1004	25/50/25	Unknown	2.493	0.172	0.250	1.869	9.97	7.48	Double	0.250	Ti bolt NAS 464-4
379 M I/N1004	50/25/25	Unknown	2.498	0.178	0.250	0.512	9.99	2.05	Double	0.250	Ti bolt NAS 464-4
380 M I/N1004	50/25/25	Unknown	2.499	0.175	0.250	0.503	10.00	2.01	Double	0.250	Ti bolt NAS 464-4
381 M I/N1004	50/25/25	Unknown	2.498	0.178	0.250	1.865	9.99	7.46	Double	0.250	Ti bolt NAS 464-4
382 M I/N1004	50/25/25	Unknown	2.499	0.175	0.250	1.866	10.00	7.46	Double	0.250	Ti bolt NAS 464-4
383 M I/N1004	50/25/25	Unknown	2.497	0.172	0.250	0.517	9.99	2.07	Double	0.250	Ti bolt NAS 464-4
384 M I/N1004	50/25/25	Unknown	2.497	0.171	0.250	0.508	9.99	2.03	Double	0.250	Ti bolt NAS 464-4
385 M I/N1004	50/25/25	Unknown	2.497	0.172	0.250	1.866	9.99	7.46	Double	0.250	Ti bolt NAS 464-4
386 M I/N1004	50/25/25	Unknown	2.497	0.171	0.250	1.864	9.99	7.46	Double	0.250	Ti bolt NAS 464-4
387 M I/N1004	75/0/25	Unknown	2.006	0.178	0.250	0.49	8.02	1.96	Double	0.250	Ti bolt NAS 464-4
388 M I/N1004	75/0/25	Unknown	2.005	0.178	0.250	0.51	8.02	2.04	Double	0.250	Ti bolt NAS 464-4
389 M I/N1004	75/0/25	Unknown	2.006	0.178	0.250	2.367	8.02	9.47	Double	0.250	Ti bolt NAS 464-4
390 M I/N1004	75/0/25	Unknown	2.005	0.178	0.250	2.364	8.02	9.46	Double	0.250	Ti bolt NAS 464-4
391 M I/N1004	75/0/25	Unknown	2.002	0.179	0.250	0.495	8.01	1.98	Double	0.250	Ti bolt NAS 464-4
392 M I/N1004	75/0/25	Unknown	2.001	0.177	0.250	0.46	8.01	1.84	Double	0.250	Ti bolt NAS 464-4
393 M I/N1004	75/0/25	Unknown	2.002	0.179	0.250	2.369	8.01	9.48	Double	0.250	Ti bolt NAS 464-4
394 M I/N1004	75/0/25	Unknown	2.001	0.177	0.250	2.264	8.00	9.46	Double	0.250	Ti bolt NAS 464-4
395 M I/N1004	0/100/0	Unknown	2.506	0.180	0.250	0.497	10.04	1.99	Double	0.250	Ti bolt NAS 464-4
396 M I/N1004	0/100/0	Unknown	2.508	0.180	0.250	0.489	10.03	1.96	Double	0.250	Ti bolt NAS 464-4
397 M I/N1004	0/100/0	Unknown	2.509	0.180	0.250	1.667	10.04	6.87	Double	0.250	Ti bolt NAS 464-4
398 M I/N1004	0/100/0	Unknown	2.508	0.180	0.250	1.16	10.03	4.72	Double	0.250	Ti bolt NAS 464-4
399 M I/N1004	0/100/0	Unknown	2.496	0.180	0.250	0.498	9.98	1.99	Double	0.250	Ti bolt NAS 464-4
400 M I/N1004	0/100/0	Unknown	2.496	0.178	0.250	0.506	9.96	2.02	Double	0.250	Ti bolt NAS 464-4
401 M I/N1004	0/100/0	Unknown	2.496	0.180	0.250	1.23	9.99	4.92	Double	0.250	Ti bolt NAS 464-4
402 M I/N1004	0/100/0	Unknown	2.496	0.178	0.250	1.205	9.98	4.82	Double	0.250	Ti bolt NAS 464-4
403 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/3/45/0/-4.5/0/5]	1.510	0.212	0.251	0.75	6.02	2.99	Doubt <sub>9</sub>	0.249	ST3M 453-4-26 bolt
404 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.510	0.212	0.249	0.73	6.06	3.01	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
405 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.510	0.212	0.249	0.75	6.05	3.01	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
406 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.510	0.212	0.251	0.75	6.02	2.99	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
407 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.511	0.229	0.249	0.75	5.95	3.01	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
408 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.481	0.229	0.249	0.75	5.95	3.01	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
409 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.481	0.229	0.250	0.75	5.92	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
410 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.481	0.229	0.250	0.75	5.92	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
411 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.505	0.197	0.250	0.75	6.02	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
412 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.505	0.197	0.250	0.75	6.02	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
413 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.505	0.197	0.249	0.75	6.04	3.01	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
414 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.505	0.197	0.250	0.75	6.02	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
415 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.503	0.208	0.249	0.75	6.04	3.01	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
416 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.505	0.203	0.250	0.75	6.02	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
417 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.506	0.207	0.250	0.75	6.02	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
418 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.507	0.213	0.250	0.75	6.13	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
419 AS1/3501-8	50/40/10	[45/0/-4.5/0/90/0/4.5/0/-4.5/0/5]	1.513	0.195	0.251	0.75	6.03	2.99	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
420 AS1/3501-8	50/40/10	[45/0/2/4.5/90/0/-4.5/0/5]	1.513	0.195	0.249	0.75	6.08	3.01	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
421 AS1/3501-8	50/40/10	[45/0/2/4.5/90/0/-4.5/0/5]	1.513	0.195	0.251	0.75	6.03	2.99	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
422 AS1/3501-8	50/40/10	[45/0/2/4.5/90/0/-4.5/0/5]	1.513	0.195	0.250	0.75	6.05	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt
423 AS1/3501-8	50/40/10	[45/0/2/4.5/90/0/-4.5/0/5]	1.507	0.193	0.250	0.75	6.03	3.00	Doubt <sub>6</sub>	0.249	ST3M 453-4-26 bolt

## Single J-Tension

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z		
377	25	RT	Unknown	6380	Unknown	149	Unknown	14.9	10.0	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II		
378	25	RT	Unknown	5990	Unknown	139	Unknown	14.0	9.3	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II		
379	25	RT	Unknown	2980	Unknown	67	Unknown	6.7	16.3	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
380	25	RT	Unknown	3085	Unknown	71	Unknown	7.1	17.5	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
381	25	RT	Unknown	8585	Unknown	148	Unknown	14.8	9.9	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
382	25	RT	Unknown	6110	Unknown	139	Unknown	14.0	9.4	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
383	25	RT	Unknown	3025	Unknown	70	Unknown	7.0	17.0	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
384	25	RT	Unknown	2980	Unknown	69	Unknown	7.0	17.2	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
385	25	RT	Unknown	6400	Unknown	149	Unknown	14.9	10.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
386	25	RT	Unknown	6470	Unknown	151	Unknown	15.2	10.1	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
387	25	RT	Unknown	2290	Unknown	52	Unknown	6.4	13.1	Unknown	Sher	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
388	25	RT	Unknown	2040	Unknown	45	Unknown	5.7	11.2	Unknown	Sher	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
389	25	RT	Unknown	6230	Unknown	140	Unknown	17.4	7.4	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
390	25	RT	Unknown	5910	Unknown	133	Unknown	16.6	7.0	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
391	25	RT	Unknown	2130	Unknown	48	Unknown	5.9	12.0	Unknown	Sher	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
392	25	RT	Unknown	2200	Unknown	49	Unknown	6.2	13.5	Unknown	Sher	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
393	25	RT	Unknown	6340	Unknown	142	Unknown	17.7	7.5	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
394	25	RT	Unknown	6090	Unknown	138	Unknown	17.2	7.3	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
395	25	RT	Unknown	3225	Unknown	74	Unknown	7.4	18.6	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
396	25	RT	Unknown	3150	Unknown	70	Unknown	7.0	17.9	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
397	25	RT	Unknown	3445	Unknown	77	Unknown	7.6	5.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
398	25	RT	Unknown	3240	Unknown	72	Unknown	7.2	7.6	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
399	25	RT	Unknown	3130	Unknown	69	Unknown	7.0	17.5	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
400	25	RT	Unknown	3250	Unknown	73	Unknown	7.3	18.0	Unknown	Tens	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
401	25	RT	Unknown	3130	Unknown	69	Unknown	7.0	7.1	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
402	25	RT	Unknown	3280	Unknown	74	Unknown	7.4	7.7	Unknown	Bear	Unknown	Hart-Smith [1-17]	Fiber: Morganite II	
403	0	RT	0.00	6880	Unknown	129	Unknown	21.5	21.6	1950	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
404	0	RT	0.00	7330	Unknown	139	Unknown	22.9	23.1	2080	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
405	0	RT	0.00	7620	Unknown	144	Unknown	23.8	24.0	2135	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
406	0	RT	0.00	7380	Unknown	139	Unknown	23.1	23.2	2140	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
407	0	RT	0.00	6240	Unknown	109	Unknown	18.4	18.2	1625	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
408	0	RT	0.00	6420	Unknown	113	Unknown	18.9	18.7	1715	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
409	0	RT	0.00	6420	Unknown	112	Unknown	18.9	18.7	1810	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
410	0	RT	0.00	6840	Unknown	119	Unknown	20.2	19.9	1915	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
411	25	RT	0.00	7180	Unknown	145	Unknown	24.1	24.2	2160	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
412	25	RT	0.00	6900	Unknown	140	Unknown	23.2	23.3	2050	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
413	25	RT	0.00	7010	Unknown	143	Unknown	23.6	23.7	2110	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
414	25	RT	0.00	6910	Unknown	140	Unknown	23.3	23.3	2105	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
415	0	250	F	0.82	3980	Unknown	77	Unknown	12.8	12.8	1190	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP
416	0	250	F	0.78	4080	Unknown	81	Unknown	13.4	13.4	1260	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP
417	0	250	F	0.80	4720	Unknown	91	Unknown	15.1	15.2	1370	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP
418	0	250	F	0.86	5280	Unknown	99	Unknown	16.4	16.5	1520	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP
419	50	RT	0.00	6310	Unknown	129	Unknown	21.4	21.6	1900	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
420	50	RT	0.00	6640	Unknown	137	Unknown	22.5	22.7	2030	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
421	50	RT	0.00	6500	Unknown	133	Unknown	22.0	22.2	2075	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
422	50	RT	0.00	6730	Unknown	138	Unknown	22.8	23.0	2245	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP	
423	50	250	F	0.75	2480	Unknown	51	Unknown	8.5	8.5	760	Sh & Br	Unknown	Garcia et al [1-38]	Gr/EP

A	B	C	D	E	F	G	H	I	J	K	L
424 AS1/3501-6	50/40/10	[45/-45/(0)2/45/90/-45/(0)3]s	1.507	0.193	0.251	0.75	6.00	2.99	Double	0.249 ST3M 453-4-26	bolt
425 AS1/3501-6	50/40/10	[45/-45/(0)2/45/90/-45/(0)3]s	1.504	0.201	0.249	0.75	6.04	3.01	Double	0.249 ST3M 453-4-26	bolt
426 AS1/3501-6	50/40/10	[45/-45/(0)2/45/90/-45/(0)3]s	1.505	0.204	0.248	0.75	6.07	3.02	Double	0.249 ST3M 453-4-26	bolt
427 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.189	0.251	0.75	6.02	2.99	Double	0.249 ST3M 453-4-26	bolt
428 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.188	0.249	0.75	6.07	3.01	Double	0.249 ST3M 453-4-26	bolt
429 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.189	0.250	0.75	6.05	3.00	Double	0.249 ST3M 453-4-26	bolt
430 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.189	0.250	0.75	6.05	3.00	Double	0.249 ST3M 453-4-26	bolt
431 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.506	0.183	0.250	0.75	6.02	3.00	Double	0.249 ST3M 453-4-26	bolt
432 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.186	0.250	0.75	6.02	3.00	Double	0.249 ST3M 453-4-26	bolt
433 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.503	0.193	0.249	0.75	6.04	3.01	Double	0.249 ST3M 453-4-26	bolt
434 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.503	0.193	0.251	0.75	5.99	2.99	Double	0.249 ST3M 453-4-26	bolt
435 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.195	0.251	0.75	6.02	2.99	Double	0.249 ST3M 453-4-26	bolt
436 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.195	0.249	0.75	6.07	3.01	Double	0.249 ST3M 453-4-26	bolt
437 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.195	0.249	0.75	6.07	3.01	Double	0.249 ST3M 453-4-26	bolt
438 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.512	0.195	0.251	0.75	6.02	2.99	Double	0.249 ST3M 453-4-26	bolt
439 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.198	0.249	0.75	6.04	3.01	Double	0.249 ST3M 453-4-26	bolt
440 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.198	0.250	0.75	6.02	3.00	Double	0.249 ST3M 453-4-26	bolt
441 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.502	0.191	0.250	0.75	6.01	3.00	Double	0.249 ST3M 453-4-26	bolt
442 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.502	0.195	0.250	0.75	6.01	3.00	Double	0.249 ST3M 453-4-26	bolt
443 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.2142	0.251	0.75	6.00	2.99	Double	0.249 ST3M 453-4-26	bolt
444 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.506	0.2142	0.250	0.75	6.02	3.00	Double	0.249 ST3M 453-4-26	bolt
445 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.506	0.2142	0.249	0.75	6.05	3.01	Double	0.249 ST3M 453-4-26	bolt
446 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.506	0.2142	0.250	0.75	6.02	3.00	Double	0.249 ST3M 453-4-26	bolt
447 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.507	0.2154	0.249	0.75	6.05	3.01	Double	0.249 ST3M 453-4-26	bolt
448 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.503	0.2141	0.250	0.75	6.01	3.00	Double	0.249 ST3M 453-4-26	bolt
449 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2013	0.250	0.75	6.02	3.00	Double	0.249 ST3M 453-4-26	bolt
450 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.201	0.250	0.75	6.02	3.00	Double	0.249 ST3M 453-4-26	bolt
451 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.2224	0.250	0.75	6.02	3.00	Single	0.249 ST3M 453-4-18	bolt
452 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.490	0.2155	0.250	0.75	5.96	3.00	Single	0.249 ST3M 453-4-18	bolt
453 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.503	0.2163	0.250	0.75	6.01	3.00	Single	0.249 ST3M 453-4-18	bolt
454 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.503	0.2208	0.249	0.75	6.04	3.01	Single	0.249 ST3M 453-4-18	bolt
455 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2115	0.251	0.50	5.93	1.99	Single	0.249 ST3M 453-4-18	bolt
456 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2221	0.251	0.50	5.99	1.99	Single	0.249 ST3M 453-4-18	bolt
457 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.501	0.211	0.250	0.50	6.00	2.00	Single	0.249 ST3M 453-4-18	bolt
458 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.1975	0.252	0.50	5.97	1.98	Single	0.249 ST3M 453-4-18	bolt
459 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.506	0.1947	0.253	0.50	5.95	1.98	Single	0.249 ST3M 453-4-18	bolt
460 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.2073	0.250	0.50	6.02	3.00	Single	0.249 ST3M 453-4-18	bolt
461 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.2073	0.249	0.75	6.04	3.01	Single	0.249 ST3M 453-4-18	bolt
462 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.506	0.1947	0.249	0.50	6.05	2.01	Single	0.249 ST3M 453-4-18	bolt
463 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.507	0.2073	0.250	0.50	6.02	2.00	Single	0.249 ST3M 453-4-18	bolt
464 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2101	0.249	0.75	6.02	3.01	Single	0.249 ST3M 453-4-18	bolt
465 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.2101	0.250	0.75	6.02	3.00	Single	0.249 ST3M 453-4-18	bolt
466 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.505	0.2073	0.249	0.75	6.04	3.01	Single	0.249 ST3M 453-4-18	bolt
467 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2101	0.250	0.75	6.02	3.00	Single	0.249 ST3M 453-4-18	bolt
468 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2101	0.249	0.75	6.03	4.03	Single	0.249 ST3M 453-4-18	bolt
469 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2101	0.250	0.75	6.02	3.00	Single	0.249 ST3M 453-4-18	bolt
470 AS1/3501-6	50/40/10	[45/-45(2/90/(0)5]s	1.504	0.2101	0.249	0.75	6.03	3.01	Single	0.249 ST3M 453-4-18	bolt

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
424	50 250 F	0.77	2850	Unknown	59	Unknown	9.8	9.8	845	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
425	50 250 F	0.81	4100	Unknown	82	Unknown	13.6	13.6	1265	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
426	50 250 F	0.82	4540	Unknown	90	Unknown	14.6	14.6	1385	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
427	50 RT	0.00	4720	Unknown	99	Unknown	16.5	16.6	1325	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
428	50 RT	0.00	4200	Unknown	89	Unknown	14.7	14.8	1165	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
429	50 RT	0.00	4200	Unknown	89	Unknown	14.7	14.8	1260	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
430	50 RT	0.00	4360	Unknown	92	Unknown	15.3	15.4	1410	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
431	50 250 F	0.68	3500	Unknown	77	Unknown	12.7	12.8	1030	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
432	50 250 F	0.75	3400	Unknown	73	Unknown	12.1	12.2	1030	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
433	50 250 F	0.78	3230	Unknown	67	Unknown	11.1	11.2	1165	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
434	50 250 F	0.78	3660	Unknown	76	Unknown	12.6	12.6	1160	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
435	50 RT	0.00	6520	Unknown	133	Unknown	22.1	22.3	1895	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
436	50 RT	0.00	7120	Unknown	147	Unknown	24.1	24.3	2105	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
437	50 RT	0.00	7180	Unknown	148	Unknown	24.4	24.5	2170	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
438	50 RT	0.00	7280	Unknown	149	Unknown	24.7	24.9	2295	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
439	50 250 F	0.74	5700	Unknown	116	Unknown	19.1	19.2	1610	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
440	50 250 F	0.74	5200	Unknown	105	Unknown	17.5	17.5	1580	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
441	50 250 F	0.66	5040	Unknown	108	Unknown	17.6	17.6	1520	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
442	50 250 F	0.73	4380	Unknown	90	Unknown	15.0	15.0	1235	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
443	50 RT	0.00	6330	Unknown	118	Unknown	19.6	19.7	1845	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
444	50 RT	0.00	6450	Unknown	120	Unknown	20.0	20.1	1940	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
445	50 RT	0.00	6400	Unknown	120	Unknown	19.8	19.8	1935	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
446	50 RT	0.00	6390	Unknown	119	Unknown	19.8	19.9	1965	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
447	50 250 F	0.87	4680	Unknown	87	Unknown	14.4	14.5	1235	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
448	50 250 F	0.87	4500	Unknown	84	Unknown	14.0	14.0	1350	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
449	50 250 F	0.80	3720	Unknown	74	Unknown	12.3	12.3	1150	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
450	50 250 F	0.80	3840	Unknown	76	Unknown	12.7	12.7	1120	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
451	50 250 F	0.93	4620	Unknown	83	Unknown	13.7	13.8	1080	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
452	50 250 F	0.83	5380	Unknown	100	Unknown	16.6	16.6	1680	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
453	50 250 F	0.88	4820	Unknown	89	Unknown	14.8	14.9	1420	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
454	50 250 F	0.89	5700	Unknown	104	Unknown	17.2	17.2	1670	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
455	50 250 F	0.82	3420	Unknown	64	Unknown	10.8	10.8	1045	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
456	50 250 F	0.92	3885	Unknown	70	Unknown	11.6	11.6	1225	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
457	50 250 F	0.85	3930	Unknown	75	Unknown	12.4	12.4	1090	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
458	50 250 F	0.76	3900	Unknown	78	Unknown	13.1	13.1	1140	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
459	50 RT	0.00	3440	Unknown	70	Unknown	11.7	11.7	1030	Sher	Unknown	Carbo et al [1-38]	Gr/EP
460	50 RT	0.00	4270	Unknown	88	Unknown	14.6	14.6	1310	Sher	Unknown	Carbo et al [1-38]	Gr/EP
461	50 RT	0.00	4430	Unknown	91	Unknown	15.1	15.1	1395	Sher	Unknown	Carbo et al [1-38]	Gr/EP
462	50 RT	0.00	4250	Unknown	87	Unknown	14.5	14.5	1350	Sher	Unknown	Carbo et al [1-38]	Gr/EP
463	50 RT	0.00	7770	Unknown	150	Unknown	24.9	24.9	2220	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
464	50 RT	0.00	6390	Unknown	124	Unknown	20.5	20.5	1820	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
465	50 RT	0.00	7160	Unknown	138	Unknown	22.9	22.9	2080	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
466	50 RT	0.00	6040	Unknown	117	Unknown	19.4	19.4	1770	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
467	50 RT	0.00	6740	Unknown	126	Unknown	32.0	32.0	2795	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
468	50 RT	0.00	6240	Unknown	119	Unknown	29.6	29.6	2590	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
469	50 RT	0.00	6220	Unknown	118	Unknown	29.5	29.5	2670	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP
470	50 RT	0.00	5860	Unknown	112	Unknown	27.8	27.8	2485	Sh & Br	Unknown	Carbo et al [1-38]	Gr/EP



M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
471	50 RT	0.00	9140 Unknown	121 Unknown	20.4	20.4	1715 Sh & Br	Unknown Garbo et al [1-38]					
472	50 RT	0.00	9200 Unknown	123 Unknown	20.5	20.5	1815 Bear	Unknown Garbo et al [1-38]					
473	50 RT	0.00	8600 Unknown	115 Unknown	19.2	19.2	1735 Sh & Br	Unknown Garbo et al [1-38]					
474	50 RT	0.00	7230 Unknown	102 Unknown	16.9	16.9	1535 Bear	Unknown Garbo et al [1-38]					
475	160 RT	0.00	8575 Unknown	121 Unknown	20.0	20.1	1730 Sh & Br	Unknown Garbo et al [1-38]					
476	50 RT	0.00	21900 Unknown	128 Unknown	21.6	21.6	1960 Shear	Unknown Garbo et al [1-38]					
477	50 RT	0.00	21400 Unknown	127 Unknown	21.1	21.1	1935 Shear	Unknown Garbo et al [1-38]					
478	50 RT	0.00	21300 Unknown	126 Unknown	21.0	21.0	1915 Shear	Unknown Garbo et al [1-38]					
479	50 RT	0.00	21500 Unknown	127 Unknown	21.2	21.2	1950 Shear	Unknown Garbo et al [1-38]					
480	160 250 F	1.15	18600 Unknown	108 Unknown	18.4	18.4	1965 Sh & Br	Unknown Garbo et al [1-38]					
481	160 250 F	1.15	16900 Unknown	107 Unknown	18.1	18.1	1735 Sh & Br	Unknown Garbo et al [1-38]					
482	160 250 F	1.16	17100 Unknown	102 Unknown	16.9	16.9	1800 Sh & Br	Unknown Garbo et al [1-38]					
483	160 250 F	1.17	17200 Unknown	102 Unknown	16.9	17.0	1830 Sh & Br	Unknown Garbo et al [1-38]					
484	50 RT	0.00	32300 Unknown	131 Unknown	22.0	22.0	2000 Shear	Unknown Garbo et al [1-38]					
485	50 RT	0.00	30900 Unknown	127 Unknown	21.1	21.1	1920 Shear	Unknown Garbo et al [1-38]					
486	50 RT	0.00	32100 Unknown	131 Unknown	21.9	21.9	1985 Shear	Unknown Garbo et al [1-38]					
487	50 RT	0.00	30700 Unknown	126 Unknown	20.9	21.0	1865 Shear	Unknown Garbo et al [1-38]					
488	160 250 F	0.88	32500 Unknown	85 Unknown	21.2	21.2	2330 Shear	Unknown Garbo et al [1-38]					
489	160 250 F	0.86	34500 Unknown	89 Unknown	22.1	22.2	2260 Shear	Unknown Garbo et al [1-38]					
490	160 250 F	0.88	34600 Unknown	91 Unknown	22.7	22.7	2260 Shear	Unknown Garbo et al [1-38]					
491	160 250 F	0.86	33400 Unknown	89 Unknown	22.1	22.1	2185 Shear	Unknown Garbo et al [1-38]					
492	50 RT	0.00	9990 Unknown	83 Unknown	20.7	20.7	1915 Shear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
493	50 RT	0.90	9240 Unknown	114 Unknown	19.2	19.2	1815 Shear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
494	160 RT	0.00	8620 Unknown	107 Unknown	17.9	17.9	1690 Shear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
495	160 RT	0.00	9850 Unknown	123 Unknown	20.5	20.5	1480 Shear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
496	50 RT	0.00	23300 Unknown	137 Unknown	22.9	22.9	2200 Sh & Br	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
497	50 RT	0.00	20500 Unknown	121 Unknown	20.2	20.2	1960 Sh & Br	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
498	50 RT	0.00	18900 Unknown	112 Unknown	18.6	18.6	1800 Sh & Br	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
499	50 RT	0.00	23300 Unknown	137 Unknown	22.9	22.9	2175 Sh & Br	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
500	50 RT	0.00	13900 Unknown	179 Unknown	30.0	30.0	1310 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
501	50 RT	0.00	13900 Unknown	180 Unknown	30.0	30.0	1180 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
502	50 RT	0.00	14800 Unknown	192 Unknown	31.9	31.9	1315 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
503	50 RT	0.00	14800 Unknown	192 Unknown	31.9	31.9	1450 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
504	50 RT	0.00	15000 Unknown	194 Unknown	32.3	32.4	1430 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
505	50 RT	0.00	15000 Unknown	194 Unknown	32.3	32.4	1470 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
506	160 RT	0.00	15975 Unknown	207 Unknown	34.4	34.5	1630 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
507	160 RT	0.00	15975 Unknown	207 Unknown	34.4	34.5	1480 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
508	50 RT	0.00	33400 Unknown	137 Unknown	22.8	22.8	2190 Ten-clev	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
509	50 RT	0.00	33700 Unknown	138 Unknown	23.0	23.0	2295 Ten-clev	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
510	50 RT	0.00	34500 Unknown	142 Unknown	23.5	23.6	2225 Ten-clev	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
511	50 RT	0.00	30100 Unknown	121 Unknown	20.5	20.6	1970 Shear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
512	50 RT	0.00	15500 Unknown	199 Unknown	33.2	33.2	1400 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
513	50 RT	0.00	15500 Unknown	199 Unknown	33.2	33.2	1390 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
514	50 RT	0.00	14800 Unknown	168 Unknown	31.3	31.3	1380 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
515	50 RT	0.00	14800 Unknown	188 Unknown	31.3	31.3	1350 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
516	50 RT	0.00	15200 Unknown	195 Unknown	32.5	32.6	1400 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				
517	50 RT	0.00	15200 Unknown	195 Unknown	32.5	32.6	1500 Bear	Unknown Garbo et al [1-38]	100 Csk x 0.756 OD, Bushing				

A	B	C	D	E	F	G	H	I	J	K	L
518 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	2.252	0.2074	0.375	1.125	6.01	3.00	Double	0.249	ST3M 430Y6-20 AS bolt
519 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	2.252	0.2074	0.251	1.125	8.97	4.48	Double	0.249	ST3M 430Y6-20 AS bolt
520 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2095	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
521 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2095	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
522 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2095	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
523 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2095	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
524 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.503	0.2138	0.250	0.750	6.01	3.00	Double	0.249	ST3M 453-4-26 bolt
525 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2237	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
526 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2109	0.251	0.750	6.00	2.99	Double	0.249	ST3M 453-4-26 bolt
527 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.508	0.2245	0.251	0.750	6.01	2.99	Double	0.249	ST3M 453-4-26 bolt
528 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2194	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
529 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2233	0.252	0.750	5.98	2.98	Double	0.249	ST3M 453-4-26 bolt
530 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.508	0.2121	0.250	0.750	6.03	3.00	Double	0.249	ST3M 453-4-26 bolt
531 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.505	0.2105	0.251	0.750	6.00	2.99	Double	0.249	ST3M 453-4-26 bolt
532 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.503	0.203	0.251	0.750	5.99	2.99	Double	0.249	ST3M 453-4-26 bolt
533 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.503	0.203	0.251	0.750	5.99	2.99	Double	0.249	ST3M 453-4-26 bolt
534 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.503	0.203	0.250	0.750	6.01	3.00	Double	0.249	ST3M 453-4-26 bolt
535 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.503	0.203	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
536 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.503	0.2103	0.251	0.750	5.99	2.99	Double	0.249	ST3M 453-4-26 bolt
537 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.503	0.2213	0.252	0.750	5.97	2.98	Double	0.249	ST3M 453-4-26 bolt
538 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.501	0.2119	0.251	0.750	5.98	2.99	Double	0.249	ST3M 453-4-26 bolt
539 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.504	0.2209	0.251	0.750	5.98	2.98	Double	0.249	ST3M 453-4-26 bolt
540 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.512	0.2061	0.251	0.750	6.02	2.99	Double	0.249	ST3M 453-4-26 bolt
541 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.512	0.2061	0.250	0.750	6.06	3.00	Double	0.249	ST3M 453-4-26 bolt
542 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.512	0.2061	0.250	0.750	6.05	3.00	Double	0.249	ST3M 453-4-26 bolt
543 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.512	0.2061	0.250	0.750	6.05	3.00	Double	0.249	ST3M 453-4-26 bolt
544 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.511	0.2041	0.251	0.750	6.01	2.98	Double	0.249	ST3M 453-4-26 bolt
545 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.508	0.2196	0.251	0.750	6.01	2.99	Double	0.249	ST3M 453-4-26 bolt
546 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.507	0.2047	0.253	0.750	5.95	2.98	Double	0.249	ST3M 453-4-26 bolt
547 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.509	0.2188	0.252	0.750	5.99	2.98	Double	0.249	ST3M 453-4-26 bolt
548 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2128	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
549 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.506	0.2128	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
550 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.507	0.2081	0.250	0.750	6.03	3.00	Double	0.249	ST3M 453-4-26 bolt
551 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.507	0.2081	0.250	0.750	6.04	3.00	Double	0.249	ST3M 453-4-26 bolt
552 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.500	0.2035	0.252	0.750	5.96	2.98	Double	0.249	ST3M 453-4-26 bolt
553 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.500	0.2035	0.251	0.750	6.03	3.01	Double	0.249	ST3M 453-4-26 bolt
554 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.500	0.1998	0.251	0.750	5.97	2.98	Double	0.249	ST3M 453-4-26 bolt
555 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	1.500	0.1999	0.251	0.750	5.98	2.99	Double	0.249	ST3M 453-4-26 bolt
556 AS1/3501-6	10/40/50	45/00/-45/90/0/90/45/90/0	1.509	0.2031	0.249	0.750	6.06	3.01	Double	0.249	ST3M 453-4-26 bolt
557 AS1/3501-6	10/40/50	45/90/-45/90/0/90/45/90/0	1.502	0.1981	0.249	0.750	6.03	3.01	Double	0.249	ST3M 453-4-26 bolt
558 AS1/3501-6	10/40/50	45/90/-45/90/0/90/45/90/0	1.502	0.2013	0.249	0.750	6.03	3.01	Double	0.249	ST3M 453-4-26 bolt
559 AS1/3501-6	10/40/50	45/90/-45/90/0/90/45/90/0	1.501	0.2035	0.249	0.750	6.05	3.01	Double	0.249	ST3M 453-4-26 bolt
560 AS1/3501-6	10/40/50	45/90/-45/90/0/90/45/90/0	1.505	0.1972	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
561 AS1/3501-6	10/40/50	45/90/-45/90/0/90/45/90/0	1.509	0.2027	0.249	0.750	6.06	3.01	Double	0.249	ST3M 453-4-26 bolt
562 AS1/3501-6	10/40/50	45/90/-45/90/0/90/45/90/0	1.506	0.2007	0.250	0.750	6.02	3.00	Double	0.249	ST3M 453-4-26 bolt
563 AS1/3501-6	10/40/50	45/90/-45/90/0/90/45/90/0	1.506	0.1977	0.249	0.750	6.05	1.01	Double	0.249	ST3M 453-4-26 bolt
564 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/18	2.254	0.2082	0.375	1.125	6.01	3.01	Double	0.375	ST3M 453-6-34 bolt

## Single J-Tension

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
518	50 F	0.00	15450	Unknown	199	Unknown	33.1	33.1	1330	Bear	Unknown	Garbo et al [1-38]	Au 100 Csk x 0.756 OD, Bushing
519	160 F	0.00	15450	Unknown	297	Unknown	33.1	33.1	1730	Bear	Unknown	Garbo et al [1-38]	Au 100 Csk x 0.756 OD, Bushing
520	160 F	0.00	7420	Unknown	142	Unknown	23.5	23.6	2115	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
521	50 F	0.00	7610	Unknown	145	Unknown	24.1	24.2	2220	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
522	50 F	0.00	7550	Unknown	144	Unknown	23.9	24.0	2180	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
523	50 F	0.00	7220	Unknown	138	Unknown	22.9	23.0	2200	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
524	- 50 F	0.90	7580	Unknown	142	Unknown	23.6	23.6	2345	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
525	- 50 F	0.88	7500	Unknown	134	Unknown	22.3	22.4	2260	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
526	50 F	0.77	7720	Unknown	146	Unknown	24.3	24.4	2280	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
527	50 F	0.88	7820	Unknown	139	Unknown	23.1	23.2	2360	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
528	50 250 F	0.89	5500	Unknown	100	Unknown	16.6	16.7	1490	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
529	50 250 F	0.90	5780	Unknown	103	Unknown	17.2	17.3	1785	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
530	50 250 F	0.81	5020	Unknown	95	Unknown	15.7	15.8	1410	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
531	50 250 F	0.81	5030	Unknown	95	Unknown	15.9	15.9	1510	Sh & Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 10 off a
532	50 F	0.00	7700	Unknown	151	Unknown	25.2	25.3	2690	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
533	50 F	0.00	7770	Unknown	153	Unknown	25.5	25.5	2760	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
534	50 F	0.00	7640	Unknown	151	Unknown	25.0	25.1	2750	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
535	50 F	0.00	7880	Unknown	151	Unknown	25.1	25.2	2795	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
536	50 250 F	0.81	5950	Unknown	113	Unknown	18.8	18.9	2195	S, B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
537	50 250 F	0.87	6200	Unknown	111	Unknown	18.6	18.7	2270	S, B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
538	50 250 F	0.80	5220	Unknown	98	Unknown	16.4	16.4	1930	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
539	50 250 F	0.87	5090	Unknown	92	Unknown	15.3	15.4	1910	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 22.5 off
540	50 F	0.00	7430	Unknown	144	Unknown	23.8	24.0	3800	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
541	50 F	0.00	7180	Unknown	143	Unknown	23.7	23.9	3740	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
542	50 F	0.00	7600	Unknown	147	Unknown	24.4	24.6	3930	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
543	50 F	0.00	7650	Unknown	148	Unknown	24.5	24.7	1610	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
544	50 250 F	0.76	6030	Unknown	118	Unknown	19.7	19.8	1560	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
545	- 50 250 F	0.87	5960	Unknown	108	Unknown	16.0	18.1	3095	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
546	50 250 F	0.81	5290	Unknown	102	Unknown	17.1	17.2	2910	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
547	50 250 F	0.88	4720	Unknown	86	Unknown	14.3	14.4	2590	S,B,T,Br	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 45 off a
548	50 F	0.00	7840	Unknown	147	Unknown	24.5	24.6	4995	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 67.5 off
549	50 F	0.00	7420	Unknown	139	Unknown	23.2	23.2	4830	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 67.5 off
550	50 F	0.00	7450	Unknown	142	Unknown	23.8	23.9	4920	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 67.5 off
551	50 F	0.00	7270	Unknown	140	Unknown	23.2	23.3	4710	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 67.5 off
552	50 F	0.00	7370	Unknown	144	Unknown	24.1	24.1	4810	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 80 off a
553	50 F	0.00	7550	Unknown	148	Unknown	24.7	24.7	5025	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 80 off a
554	50 F	0.00	6750	Unknown	134	Unknown	22.5	22.5	4395	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 80 off a
555	50 F	0.00	7330	Unknown	146	Unknown	24.4	24.4	4840	Sh, Te-Bi	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 80 off a
556	50 F	0.00	6240	Unknown	123	Unknown	20.4	20.5	2270	Tens	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
557	50 F	0.00	6380	Unknown	128	Unknown	21.3	21.3	2270	Tens	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
558	50 F	0.00	6580	Unknown	131	Unknown	21.8	21.8	2340	Tens	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
559	50 F	0.00	6810	Unknown	134	Unknown	22.2	22.3	2410	Tens	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
560	50 250 F	0.79	4820	Unknown	98	Unknown	18.2	18.3	3780	Be & Te	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
561	50 250 F	0.78	5400	Unknown	105	Unknown	17.3	17.4	3905	Bear	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
562	50 250 F	0.79	4320	Unknown	86	Unknown	14.3	14.3	3490	Be & Te	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
563	50 250 F	0.78	4570	Unknown	93	Unknown	15.3	15.4	3800	Be & Te	Unknown	Garbo et al [1-38]	Bushing bel. bo-sp. 90 off a
564	0 + Gap F	0.00	7380	Unknown	94	Unknown	15.7	15.7	1460	Bear	Unknown	Garbo et al [1-38]	1316 NDT 14 OD Fl washer Bush

A	B	C	D	E	F	G	H	I	J	K	L
565 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2184	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
566 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2212	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
567 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2274	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
568 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2298	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
569 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.253	0.2298	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
570 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2149	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
571 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.253	0.2058	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
572 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2276	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
573 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2249	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
574 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2259	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
575 AS1/3501-6	50/40/10	45/0/-45/0/90/0/45/0/-45/0/s	2.254	0.2270	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
576 AS1/3501-6	30/60/10	45/0/-45/0/45/30/-45/0/45/30	2.253	0.2297	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
577 AS1/3501-6	30/60/10	45/0/-45/0/45/80/-45/0/45/30	2.253	0.2250	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
578 AS1/3501-6	30/60/10	45/0/-45/0/45/90/-45/0/45/30	2.253	0.2278	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
579 AS1/3501-6	19/76/5	(450/450)(+450/390)(-454/510)(0/45/0/45/45)	2.251	0.2448	0.375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
580 AS1/3501-6	19/76/5	(450/450)(+450/390)(-454/510)(0/45/0/45/45)	2.251	0.2381	0.375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
581 AS1/3501-6	19/76/5	(450/450)(+450/390)(-454/510)(0/45/0/45/45)	2.250	0.2300	0.375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
582 AS1/3501-6	50/40/10	1±45/0/2/90/0/±45/0/2/9	2.253	0.2313	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
583 AS1/3501-6	50/40/10	1±45/0/2/90/0/±45/0/2/9	2.253	0.2227	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
584 AS1/3501-6	50/40/10	1±45/(C)2/90/0/±45/0/2/9	2.253	0.2289	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
585 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	2.251	0.2462	0.375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
586 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	2.250	0.2365	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
587 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	2.249	0.2438	C 375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
588 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.254	0.2205	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
589 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2299	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
590 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.253	0.2290	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
591 AS1/3501-6	19/76/5	(450/450)(+45/3/90)(-454/510)(0/45/0/45/45)	2.251	0.2318	0.375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
592 AS1/3501-6	19/76/5	(450/450)(+45/3/90)(-454/510)(0/45/0/45/45)	2.251	0.2438	C 375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
593 AS1/3501-6	19/76/5	(450/450)(+45/3/90)(-454/510)(0/45/0/45/45)	2.251	0.2205	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
594 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.255	0.2299	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
595 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.253	0.2290	0.375	1.125	6.01	3.00	Double	0.375 ST3M 453-6-34	bolt
596 AS1/3501-6	19/76/5	(450/450)(+45/3/90)(-454/510)(0/45/0/45/45)	2.251	0.2318	0.375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
597 AS1/3501-6	19/76/5	(450/450)(+45/3/90)(-454/510)(0/45/0/45/45)	2.251	0.2438	C 375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
598 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	1.507	0.2289	0.375	1.125	6.00	3.00	Double	0.375 ST3M 453-6-34	bolt
599 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	1.506	0.2236	0.375	1.500	4.02	4.00	Double	0.375 ST3M 453-6-34	bolt
600 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	1.506	0.2171	0.375	1.500	4.02	4.00	Double	0.375 ST3M 453-6-34	bolt
601 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	1.500	0.2465	0.375	1.125	4.00	3.00	Double	0.375 ST3M 453-6-34	bolt
602 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	1.500	0.2337	0.375	1.125	4.00	3.00	Double	0.375 ST3M 453-6-34	bolt
603 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	1.496	0.2483	0.375	1.125	3.99	3.00	Double	0.375 ST3M 453-6-34	bolt
604 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	1.124	0.2437	0.375	1.125	3.00	3.00	Double	0.375 ST3M 453-6-34	bolt
605 AS1/3501-6	19/76/5	(±450/0/24/+45/2/90)(-454/510)(2)(N/45/45)	1.124	0.2474	0.375	1.125	3.00	3.00	Double	0.375 ST3M 453-6-34	bolt
606 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.250	0.2274	0.369	1.125	9.10	3.05	Double	0.375 ST3M 759V6-18	pin
607 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.254	0.2124	0.369	1.125	9.11	3.05	Double	0.375 ST3M 759V6-18	pin
608 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.254	0.2274	0.371	1.125	6.08	3.03	Double	0.375 ST3M 759V6-18	pin
609 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.254	0.2079	0.375	1.125	6.01	3.00	Single	0.375 ST3M 453-6-18	bolt
610 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.253	0.2309	0.375	1.125	6.01	3.00	Single	0.375 ST3M 453-6-18	bolt
611 AS1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/s	2.253	0.2298	0.375	1.125	6.01	3.00	Single	0.375 ST3M 453-6-18	bolt

N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
565 0 + Gap RT	0.00	7500 Unknown	92 Unknown	15.2	15.3	1352 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
566 0 + Gap RT	0.00	7720 Unknown	93 Unknown	15.5	15.5	1390 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
567 0 + Gap RT	0.85	7150 Unknown	84 Unknown	13.9	14.0	1458 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
568 0 + Gap RT	0.62	7300 Unknown	86 Unknown	14.3	14.4	1410 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
569 0 + Gap RT	0.82	7300 Unknown	85 Unknown	14.1	14.1	1420 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
570 0 + Gap 250 F	0.78	4820 Unknown	60 Unknown	9.9	10.0	858 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
571 0 + Gap 250 F	0.71	3475 Unknown	45 Unknown	7.5	7.5	660 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
572 0 + Gap 250 F	0.82	4340 Unknown	51 Unknown	8.5	8.5	840 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
573 0 + Gap RT	0.89	7000 Unknown	83 Unknown	13.8	13.8	1400 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
574 0 + Gap RT	0.91	7130 Unknown	84 Unknown	14.0	14.0	1380 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
575 0 + Gap RT	0.86	6940 Unknown	82 Unknown	13.6	13.6	1380 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
576 0 + Gap RT	0.00	7500 Unknown	87 Unknown	14.5	14.5	1925 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
577 0 + Gap RT	0.00	7500 Unknown	89 Unknown	14.8	14.8	1900 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
578 0 + Gap RT	0.00	7430 Unknown	87 Unknown	14.5	14.5	1900 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
579 0 + Gap RT	0.00	8050 Unknown	88 Unknown	14.6	14.6	2670 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
580 0 + Gap RT	0.00	7750 Unknown	87 Unknown	14.5	14.5	2665 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
581 0 + Gap RT	0.00	7750 Unknown	90 Unknown	15.0	15.0	2600 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
582 0 + Gap RT	0.00	6850 Unknown	79 Unknown	13.1	13.2	1235 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
583 0 + Gap RT	0.00	7500 Unknown	90 Unknown	14.9	15.0	1365 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
584 0 + Gap RT	0.00	7350 Unknown	86 Unknown	14.3	14.3	1400 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
585 0 + Gap RT	0.00	8000 Unknown	87 Unknown	14.4	14.4	2665 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
586 0 + Gap RT	0.00	7800 Unknown	98 Unknown	14.7	14.7	2575 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
587 0 + Gap RT	0.00	8400 Unknown	92 Unknown	15.3	15.3	2915 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
588 150 RT	0.00	9060 Unknown	110 Unknown	18.2	18.3	1625 Shear	Unknown	Garbo et al [1-38]	Bushing bo-sp for load block				
589 150 RT	0.00	9690 Unknown	112 Unknown	16.7	18.7	1705 Ten-clev	Unknown	Garbo et al [1-38]	Bushing bo-sp for load block				
590 160 RT	0.00	9300 Unknown	108 Unknown	18.0	18.0	1755 Shear	Unknown	Garbo et al [1-38]	Bushing bo-sp for load block				
591 160 RT	0.00	12530 Unknown	144 Unknown	24.0	24.0	70 Tens	Unknown	Garbo et al [1-38]	Bushing bo-sp for load block				
592 160 RT	0.20	12640 Unknown	138 Unknown	23.0	23.0	42C5 Ten-clev	Unknown	Garbo et al [1-38]	Bushing bo-sp for load block				
593 160 RT	0.00	12530 Unknown	138 Unknown	23.0	23.0	4145 Ten-clev	Unknown	Garbo et al [1-38]	Bushing bo-sp for load block				
594 0 + Gap RT	0.00	7620 Unknown	88 Unknown	21.9	14.6	2040 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
595 0 + Gap RT	0.00	7080 Unknown	88 Unknown	21.9	14.7	2035 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
596 0 + Gap RT	0.00	7620 Unknown	92 Unknown	22.3	15.3	2555 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
597 0 + Gap RT	0.00	7470 Unknown	87 Unknown	21.7	10.9	2095 Ten-clev	Unknown	Garbo et al [1-38]	12/6 IDx1/4 OD F1 washer,Bus				
598 0 + Gap RT	0.00	7620 Unknown	91 Unknown	22.6	11.4	2165 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
599 0 + Gap RT	0.00	7740 Unknown	95 Unknown	23.7	11.9	2216 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
600 0 + Gap RT	0.00	9225 Unknown	100 Unknown	25.1	16.7	4800 Tens	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
601 0 + Gap RT	0.00	7275 Unknown	82 Unknown	20.5	13.6	3400 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
602 0 + Gap RT	0.00	7450 Unknown	81 Unknown	20.2	13.4	3610 Bear	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
603 0 + Gap RT	0.00	6420 Unknown	70 Unknown	23.4	11.7	40CS Tens	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
604 0 + Gap RT	0.00	6280 Unknown	68 Unknown	22.6	11.3	3805 Tens	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
605 0 + Gap RT	0.00	6360 Unknown	70 Unknown	23.3	11.6	3890 Tens	Unknown	Garbo et al [1-38]	13/6 IDx1/4 OD F1 washer,Bus				
606 0 + Gap RT	0.00	8100 Unknown	97 Unknown	15.8	15.8	1730 Shear	Unknown	Garbo et al [1-38]	Bushing pin-sp for load block				
607 0 + Gap RT	0.00	7350 Unknown	94 Unknown	15.4	15.4	1548 Ten-clev	Unknown	Garbo et al [1-38]	Bushing pin-sp for load block				
608 0 + Gap RT	0.00	8850 Unknown	105 Unknown	17.2	17.3	1450 Shear	Unknown	Garbo et al [1-38]	Bushing pin-sp for load block				
609 160 RT	0.00	8950 Unknown	115 Unknown	19.1	19.1	1770 Ten-clev	Unknown	Garbo et al [1-38]	Protruding bolt head				
610 160 RT	0.00	9100 Unknown	105 Unknown	17.5	17.5	1830 Shear	Unknown	Garbo et al [1-38]	Protruding bolt head				
611 160 RT	0.00	9700 Unknown	113 Unknown	18.7	18.8	1890 Bear	Unknown	Garbo et al [1-38]	Protruding bolt head				

## Single J-Tension

A	B	C	D	E	F	G	H	I	J	K	L
612 AS1/3501-6	50/40/10	(45/0/-45/0/90/0/45/0/-45/0/15	2.253	0.2294	0.375	1.125	6.01	3.00	Single	0.375	ST3M 430V6-18AS bolt
613 AS1/3501-6	50/40/10	(45/0/-45/0/90/0/45/0/-45/0/15	2.254	0.2238	0.375	1.125	6.01	3.00	Single	0.375	ST3M 430V6-18AS bolt
614 AS1/3501-6	50/40/10	(45/0/-45/0/90/0/45/0/-45/0/15	2.254	0.2148	0.375	1.125	6.01	3.00	Single	0.375	ST3M 430V6-18AS bolt
615 AS1/3501-6	50/40/10	(45/0/-45/0/90/0/45/0/-45/0/15	2.250	0.2254	0.376	1.125	5.98	2.99	Double	0.375	ST3M 453-6-34 bolt
616 AS1/3501-6	50/40/10	(45/0/-45/0/90/0/45/0/-45/0/15	2.250	0.2321	0.376	1.125	5.98	2.99	Double	0.375	ST3M 453-6-34 bolt
617 AS1/3501-6	50/40/10	(45/0/-45/0/90/0/45/0/-45/0/15	2.250	0.2271	0.375	1.125	6.00	3.00	Double	0.375	ST3M 453-6-34 bolt
618 AS4/3501-6	49/39/12	Unknown	0.998	0.213	0.250	0.75	3.99	3.00	Single	0.250	T1 Csk tension-head
619 AS4/3501-6	49/39/12	Unknown	1.000	0.260	0.250	0.75	4.00	3.00	Single	0.250	T1 Csk tension-head
620 AS4/3501-6	49/39/12	Unknown	0.999	0.213	0.250	0.75	4.00	3.00	Single	0.250	SI Csk tension-head
621 AS4/3501-6	49/39/12	Unknown	1.001	0.260	0.250	0.75	4.00	3.00	Single	0.250	SI Csk tension-head
622 AS4/3501-6	49/39/12	Unknown	1.250	0.213	0.313	0.939	3.99	3.00	Single	0.312	T1 Csk tension-head
623 AS4/3501-6	49/39/12	Unknown	1.251	0.260	0.313	0.939	4.00	3.00	Single	0.312	T1 Csk tension-head
624 AS4/3501-6	49/39/12	Unknown	1.249	0.213	0.313	0.939	3.99	3.00	Single	0.312	SI Csk tension-head
625 AS4/3501-6	49/39/12	Unknown	1.250	0.260	0.313	0.939	3.99	3.00	Single	0.312	SI Csk tension-head
626 AS4/3501-6	60/30/10	Unknown	1.001	0.213	0.250	0.75	4.00	3.00	Single	0.250	T1 Csk tension-head
627 AS4/3501-6	60/30/10	Unknown	0.999	0.260	0.250	0.75	4.00	3.00	Single	0.250	T1 Csk tension-head
628 AS4/3501-6	60/30/10	Unknown	1.001	0.213	0.250	0.75	4.00	3.00	Single	0.250	SI Csk tension-head
629 AS4/3501-6	60/30/10	Unknown	0.999	0.260	0.250	0.75	4.00	3.00	Single	0.250	SI Csk tension-head
630 AS4/3501-6	60/30/10	Unknown	1.249	0.213	0.311	0.939	3.99	3.00	Single	0.312	SI Csk tension-head
631 AS4/3501-6	60/30/10	Unknown	1.250	0.260	0.313	0.939	3.99	3.00	Single	0.312	T1 Csk tension-head
632 AS4/3501-6	60/30/10	Unknown	1.250	0.213	0.313	0.939	3.99	3.00	Single	0.312	SI Csk tension-head
633 AS4/3501-6	60/30/10	Unknown	1.250	0.260	0.313	0.939	3.99	3.00	Single	0.312	SI Csk tension-head
634 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.501	0.119	0.249	0.754	6.03	3.03	Single	0.250	SI Pr. head 51B464-4A8
635 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.501	0.119	0.250	0.758	6.00	3.03	Single	0.250	SI Pr. head 51B464-4A6
636 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.501	0.118	0.249	0.741	6.03	2.98	Single	0.250	SI Pr. head 51B464-4A8
637 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.675	0.121	0.311	0.937	6.03	3.01	Single	0.213	SI Pr. head 51B464-5A8
638 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.878	0.120	0.314	0.937	6.03	3.00	Single	0.250	SI Pr. head 51B464-5A8
639 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.119	0.314	0.939	5.97	2.99	Single	0.313	SI Pr. head 51B464-5A8
640 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	3.000	0.120	0.500	1.500	6.00	3.00	Single	0.500	SI Pr. head 51B464-5A8
641 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	3.000	0.117	0.500	1.471	6.00	2.94	Single	0.500	SI Pr. head 51B464-5A8
642 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	3.000	0.120	0.500	1.501	6.00	3.00	Single	0.500	SI Pr. head 51B464-5A8
643 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	4.502	0.119	0.750	2.258	6.00	3.01	Single	0.750	SI Pr. head 51B464-5A8
644 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	4.502	0.121	0.750	2.249	6.00	3.00	Single	0.750	SI Pr. head 51B464-5A8
645 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	4.502	0.119	0.750	2.251	6.00	3.00	Single	0.750	SI Pr. head 51B464-5A8
646 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.121	0.311	0.470	6.03	1.51	Single	0.313	SI Pr. head 51B464-5A8
647 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.115	0.314	0.470	5.97	1.50	Single	0.313	SI Pr. head 51B464-5A8
648 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.875	0.121	0.311	0.702	6.03	2.28	Single	0.313	SI Pr. head 51B464-5A8
649 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.119	0.314	0.708	5.97	2.25	Single	0.313	SI Pr. head 51B464-5A8
650 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.875	0.120	0.314	0.700	5.97	2.23	Single	0.313	SI Pr. head 51B464-5A8
651 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.120	0.311	1.247	6.03	4.01	Single	0.313	SI Pr. head 51B464-5A8
652 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.120	0.315	1.342	5.96	4.28	Single	0.313	SI Pr. head 51B464-5A8
653 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.875	0.120	0.314	1.352	5.97	4.31	Single	0.313	SI Pr. head 51B464-5A8
654 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.120	0.311	1.580	6.03	5.02	Single	0.313	SI Pr. head 51B464-5A8
655 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.877	0.121	0.314	1.558	5.98	4.96	Single	0.313	SI Pr. head 51B464-5A8
656 AS1/3501-6	50/40/10	(45/0/-45/0/2/0/90/3	1.876	0.120	0.314	1.564	5.97	4.98	Single	0.313	SI Pr. head 51B464-5A8

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
612	160	RT	0.00	8050	Unknown	94	Unknown	15.6	1395	Sh, Te-cl	Unknown	Garbo et al [1-38]	100 Csk x 0.756 O.D.
613	160	RT	0.00	8400	Unknown	100	Unknown	16.7	1500	Sh, Te-cl	Unknown	Garbo et al [1-38]	100 Csk x 0.756 O.D.
614	160	RT	0.00	8150	Unknown	101	Unknown	16.8	1455	Shear	Unknown	Garbo et al [1-38]	100 Csk x 0.756 O.D.
6150 + Gap	RT	0.00	7860	Unknown	93	Unknown	15.5	1465	Bear	Unknown	Garbo et al [1-38]	13/16 Dx/4 OD Fl washer,Bus	
6160 + Gap	RT	0.00	7460	Unknown	85	Unknown	14.3	1395	Bear	Unknown	Garbo et al [1-38]	13/16 Dx/4 OD Fl washer,Bus	
6170 + Gap	RT	0.00	8100	Unknown	95	Unknown	15.9	1545	Bear	Unknown	Garbo et al [1-38]	13/16 Dx/4 OD Fl washer,Bus	
618	95	RT	0.00	4979	Unknown	94	Unknown	23.4	2139	Unknown	218.5 Averill Zamani [2-7] Ti TenS=160 ksi. Data=Avg 3 sp	Ti TenS=160 ksi. Data=Avg 3 sp	
619	95	RT	0.00	5563	Unknown	86	Unknown	21.4	2275	Unknown	270.2 Averill Zamani [2-7] Tu TenS=160 ksi. Data=Avg 3 sp	Tu TenS=160 ksi. Data=Avg 3 sp	
620	95	RT	0.00	6067	Unknown	114	Unknown	28.5	19.0	2122	Unknown	258.9 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp
621	95	RT	0.00	6452	Unknown	99	Unknown	24.8	16.5	2234	Unknown	161 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp
622 155/80	RT	0.00	6823	Unknown	102	Unknown	25.6	17.1	2122	Unknown	1382.9 Averill Zamani [2-7] Ti TenS=160 ksi. Data=Avg 3 sp	Ti TenS=160 ksi. Data=Avg 3 sp	
623 155/80	RT	0.00	8152	Unknown	100	Unknown	25.1	16.7	2320	Unknown	1211.5 Averill Zamani [2-7] Ti TenS=160 ksi. Data=Avg 3 sp	Ti TenS=160 ksi. Data=Avg 3 sp	
624 155/80	RT	0.00	7178	Unknown	108	Unknown	27.0	17.9	2142	Unknown	389.9 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp	
625 155/80	RT	0.00	8732	Unknown	107	Unknown	26.9	17.9	1943	Unknown	398.9 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp	
626	95	RT	0.00	4941	Unknown	93	Unknown	23.2	15.5	2136	Unknown	152.7 Averill Zamani [2-7] Ti TenS=160 ksi. Data=Avg 3 sp	Ti TenS=160 ksi. Data=Avg 3 sp
627	95	RT	0.00	5522	Unknown	85	Unknown	21.3	14.2	1585	Unknown	280.2 Averill Zamani [2-7] Ti TenS=160 ksi. Data=Avg 3 sp	Ti TenS=160 ksi. Data=Avg 3 sp
628	95	RT	0.00	5537	Unknown	104	Unknown	26.0	17.3	1562	Unknown	266 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp
629	95	RT	0.00	6137	Unknown	94	Unknown	23.6	15.7	2034	Unknown	184.9 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp
630 155/80	RT	0.00	6527	Unknown	98	Unknown	24.5	16.3	2120	Unknown	567 Averill Zamani [2-7] Ti TenS=160 ksi. Data=Avg 3 sp	Ti TenS=160 ksi. Data=Avg 3 sp	
631 155/80	RT	0.00	7601	Unknown	93	Unknown	23.4	15.6	2009	Unknown	433.4 Averill Zamani [2-7] Ti TenS=160 ksi. Data=Avg 3 sp	Ti TenS=160 ksi. Data=Avg 3 sp	
632 155/80	RT	0.00	6488	Unknown	97	Unknown	24.4	16.2	2335	Unknown	305.4 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp	
633 155/80	RT	0.00	7769	Unknown	95	Unknown	23.9	15.9	2211	Unknown	328.4 Averill Zamani [2-7] St TenS=220 ksi. Data=Avg 3 sp	St TenS=220 ksi. Data=Avg 3 sp	
634	100	RT	0.00	3936	132.8	22.0	21.9	2138	Ten-clev	Rankumar...[1-25]	Rankumar...[1-25]	Rankumar...[1-25]	
635	100	RT	0.00	4104	94.12	137.9	15.7	23.0	22.7	2275	Ten-clev	147.0 Rankumar...[1-25]	Rankumar...[1-25]
636	100	RT	0.00	3781	74.88	128.7	12.4	21.3	21.6	2122	Clev	145.0 Rankumar...[1-25]	Rankumar...[1-25]
637	100	RT	0.00	4856	129.0	59.83	21.4	21.4	2234	Sh, Split	Rankumar...[1-25]	Rankumar...[1-25]	
638	100	RT	0.00	4660	45.12	123.7	7.5	20.7	20.7	2122	Sh, Sp, de	286.0 Rankumar...[1-25]	Rankumar...[1-25]
639	100	RT	0.00	5227	61.55	139.9	10.3	23.4	23.4	2320	Del, Clev	146.0 Rankumar...[1-25]	Rankumar...[1-25]
640	100	RT	0.00	6538	71.34	94.1	13.2	18.2	18.2	2142	Shear	Rankumar...[1-25]	Rankumar...[1-25]
641	100	RT	0.00	6216	59.83	106.3	10.0	17.7	18.1	1943	Bear, Spil	280.0 Rankumar...[1-25]	Rankumar...[1-25]
642	100	RT	0.00	6595	70.00	109.9	11.7	18.3	18.3	2138	Bear, Del	170.0 Rankumar...[1-25]	Rankumar...[1-25]
643	100	RT	0.00	8183	7.59	91.7	11.8	15.3	15.2	2165	Shear, Del	Rankumar...[1-25]	Rankumar...[1-25]
644	100	RT	0.00	8537	71.34	94.1	13.2	15.7	2158	Shear	333.0 Rankumar...[1-25]	Rankumar...[1-25]	
645	100	RT	0.00	8647	88.14	97.7	14.7	16.3	2294	Shear, Del	370.0 Rankumar...[1-25]	Rankumar...[1-25]	
646	100	RT	0.00	3400	31.89	90.4	5.3	15.0	29.9	1585	Shear, Del	303.0 Rankumar...[1-25]	Rankumar...[1-25]
647	100	RT	0.00	3527	31.46	97.7	5.1	16.3	32.6	1562	Shear, Del	163.0 Rankumar...[1-25]	Rankumar...[1-25]
648	100	RT	0.00	4499	1.00	119.6	0.0	19.8	28.5	2034	Del, Clev	Rankumar...[1-25]	Rankumar...[1-25]
649	100	RT	0.00	4640	10.05	124.2	17.9	20.8	27.6	2120	Shear, Del	188.0 Rankumar...[1-25]	Rankumar...[1-25]
650	100	RT	0.00	4529	11.46	120.2	18.7	20.1	27.0	2009	Shear, Del	194.0 Rankumar...[1-25]	Rankumar...[1-25]
651	100	RT	0.00	5037	109.88	135.0	18.2	22.4	16.8	2335	Bear, spil	Rankumar...[1-25]	Rankumar...[1-25]
652	100	RT	0.00	4875	95.24	129.0	16.0	21.7	15.1	2211	Bear, spil	194.0 Rankumar...[1-25]	Rankumar...[1-25]
653	100	RT	0.00	5189	106.16	137.7	17.8	23.1	16.0	2374	Br, Sp, De	200.0 Rankumar...[1-25]	Rankumar...[1-25]
654	100	RT	0.00	5184	34.83	138.4	5.8	22.9	13.8	2441	Bear, spil	Rankumar...[1-25]	Rankumar...[1-25]
655	100	RT	0.00	5050	50.01	133.1	8.4	22.3	13.4	2197	Bear, spil	143.0 Rankumar...[1-25]	Rankumar...[1-25]
656	100	RT	0.00	5139	61.04	136.4	10.2	22.8	13.7	2360	Bear, spil	164.0 Rankumar...[1-25]	Rankumar...[1-25]

## Single J-Tension

A	B	C	D	E	F	G	H	I	J	K
657 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.876	0.121	0.314	0.467	5.97	1.49	Single	0.313 Si Pr. head 51B464 SA8
658 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.875	0.108	0.314	0.472	5.97	1.50	Single	0.313 Si Pr. head 51B464 SA8
659 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.875	0.118	0.314	0.472	5.97	1.50	Single	0.313 Si Pr. head 51B464 SA8
660 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.876	0.122	0.314	1.558	5.97	4.98	Single	0.313 Si Pr. head 51B464 SA8
661 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.876	0.115	0.314	1.562	5.97	4.97	Single	0.313 Si Pr. head 51B464 SA8
662 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.875	0.119	0.314	1.559	5.97	4.98	Single	0.313 Si Pr. head 51B464 SA8
663 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.875	0.121	0.313	0.936	5.99	2.99	Single	0.313 Si Csk-T 51B335-9
664 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.876	0.120	0.316	0.935	5.94	2.98	Single	0.313 Si Csk-T 51B335-9
665 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.876	0.118	0.315	0.937	5.96	2.97	Single	0.313 Si Csk-T 51B335-9
666 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.875	0.122	0.311	0.938	6.03	3.02	Single	0.313 Si Csk-S 51B581 SA8
667 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.876	0.120	0.315	0.939	5.96	2.98	Single	0.313 Si Csk-S 51B581 SA8
668 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)s	1.875	0.119	0.314	0.940	5.97	2.99	Single	0.313 Si Csk-S 51B581 SA8
669 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.875	0.119	0.314	0.467	5.97	1.49	Single	0.313 Si Pr. head 51B464 SA3
670 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.876	0.119	0.314	0.468	5.97	1.49	Single	0.313 Si Pr. head 51B464 SA8
671 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.875	0.119	0.314	0.470	5.97	1.50	Single	0.313 Si Pr. head 51B464 SA8
672 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.875	0.120	0.314	1.557	5.97	4.98	Single	0.313 Si Pr. head 51B464 SA8
673 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.876	0.119	0.314	0.934	5.97	2.97	Single	0.313 Si Pr. head 51B464 SA8
674 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.875	0.120	0.315	1.559	5.96	4.95	Single	0.313 Si Pr. head 51B464 SA8
675 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.875	0.120	0.313	0.932	5.99	2.98	Single	0.313 Si Csk-T 51B335-9
676 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.876	0.120	0.314	0.935	5.97	2.98	Single	0.313 Si Csk-S NAS1581V5.8
677 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.876	0.119	0.314	0.937	5.97	2.98	Single	0.313 Si Csk-S NAS1581V5.8
678 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)1	1.876	0.122	0.311	0.931	6.03	3.01	Single	0.313 Si Pr. head 51B464 SA8
679 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)1	1.875	0.120	0.315	0.938	5.95	2.98	Single	0.313 Si Pr. head 51B464 SA8
680 AS1/3501-6	70/20/10	(45/0/-4.5/(0/3/90/(0/1)3)1	1.876	0.120	0.314	0.937	5.97	2.98	Single	0.313 Si Pr. head 51B464 SA8
681 AS1/3501-6	30/60/10	(45/0/-4.5/(0/45/90/45/0/45/45)s	1.875	0.118	0.311	0.936	6.03	3.01	Single	0.313 Si Pr. head 51B464 SA8
682 AS1/3501-6	30/60/10	(45/0/-4.5/(0/3/90/(0/1)3)1	1.875	0.120	0.315	0.938	5.95	2.98	Single	0.313 Si Pr. head 51B464 SA8
683 AS1/3501-6	30/60/10	(45/0/-4.5/(0/3/90/(0/1)3)1	1.874	0.119	0.311	0.935	6.03	3.01	Single	0.313 Si Pr. head 51B464 SA8
684 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	3.626	0.116	0.312	0.939	2.01	3.01	Single	0.313 Si Pr. head 51B464 SA8
685 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	0.625	0.119	0.312	0.943	2.00	3.02	Single	0.313 Si Pr. head 51B464 SA8
686 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	0.626	0.113	0.314	0.942	1.99	2.97	Single	0.313 Si Pr. head 51B464 SA8
687 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.248	0.121	0.311	0.937	4.01	3.01	Single	0.313 Si Pr. head 51B464 SA8
688 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.250	0.116	0.312	0.937	4.01	3.00	Single	0.313 Si Pr. head 51B464 SA8
689 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.250	0.119	0.312	0.938	4.01	3.01	Single	0.313 Si Pr. head 51B464 SA8
690 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	2.500	0.120	0.312	0.938	8.01	3.01	Single	0.313 Si Pr. head 51B464 SA8
691 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	2.500	0.116	0.312	0.936	5.94	2.98	Single	0.313 Si Pr. head 51B464 SA8
692 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	2.500	0.118	0.312	0.938	8.01	3.00	Single	0.313 Si Pr. head 51B464 SA8
693 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.876	0.120	0.315	0.934	5.97	2.98	Single	0.313 Si Csk-T 51B335-9
694 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.876	0.117	0.315	0.940	5.96	2.98	Single	0.313 Si Csk-T 51B335-9
695 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.876	0.112	0.316	0.936	5.94	2.98	Single	0.313 Si Csk-T 51B335-9
696 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.877	0.116	0.315	0.943	5.96	2.99	Single	0.313 Si Csk-S 51B5851-5-B
697 AS1/3501-6	50/40/10	((45/0/-4.5/(0/2/90/0)3)1	1.875	0.113	0.314	0.935	5.97	2.98	Single	0.313 Si Csk-S 51B5851-5-B
698 AS1/3501-6	70/20/10	((45/0/-4.5/(0/3/90/(0/1)3)s	0.628	0.117	0.312	0.941	2.01	3.02	Single	0.313 Si Pr. head 51B464 SA8
699 AS1/3501-6	70/20/10	((45/0/-4.5/(0/3/90/(0/1)3)s	0.624	0.117	0.311	0.935	2.01	3.01	Single	0.313 Si Pr. head 51B464 SA8
700 AS1/3501-6	70/20/10	((45/0/-4.5/(0/3/90/(0/1)3)s	0.628	0.118	0.312	0.939	2.01	3.01	Single	0.313 Si Pr. head 51B464 SA8

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
657	100 RT	0.00	2628	-21.06	69.2	3.5	11.6	23.3	9.41	Sher, Ten	143.0	Ramkumar...[1-25]	
658	100 RT	0.00	2462	23.59	72.6	4.0	12.2	24.1	885	Sher, Del	160.0	Ramkumar...[1-25]	
659	100 RT	0.00	2384	16.19	64.3	2.7	10.8	21.4	896	Shear	108.0	Ramkumar...[1-25]	
660	100 RT	0.00	5061	83.53	132.1	14.0	22.1	13.3	1807	Shear	185.0	Ramkumar...[1-25]	
661	100 RT	0.00	4721	110.77	131.0	18.5	21.9	13.2	1806	Shear	185.0	Ramkumar...[1-25]	
662	100 RT	0.00	5208	90.99	139.4	15.2	23.3	14.0	1998	Shear	188.0	Ramkumar...[1-25]	
663	100 RT	0.00	3449	44.89	91.1	7.5	15.2	15.2	1237	Shear	188.0	Ramkumar...[1-25] Ten. head Csk depth = .10"	
664	100 RT	0.00	3332	55.38	87.9	9.3	14.8	14.8	1201	Shear	98.0	Ramkumar...[1-25] Ten. head Csk depth = .10"	
665	100 RT	0.00	3156	34.97	84.9	5.9	14.3	14.3	1161	Shear	85.0	Ramkumar...[1-25] Ten. head Csk depth = .10"	
666	100 RT	0.00	3073	36.90	81.0	6.1	13.4	13.4	1118	Shear	145.0	Ramkumar...[1-25] Shear head Csk depth = .07"	
667	100 RT	0.00	2999	26.46	79.3	4.4	13.3	13.3	1098	Shear	190.0	Ramkumar...[1-25] Shear head Csk depth = .07"	
668	100 RT	0.00	3341	32.11	89.4	5.4	15.0	14.9	1232	Shear, Del	167.0	Ramkumar...[1-25] Shear head Csk depth = .07"	
669	100 RT	0.00	3390	85.64	90.7	14.3	15.2	30.5	2118	Clev, Del	140.0	Ramkumar...[1-25]	
670	100 RT	0.00	3478	74.93	93.1	12.5	15.6	31.2	2190	Clev, Del	145.0	Ramkumar...[1-25]	
671	100 RT	0.00	3371	77.61	90.2	13.0	15.1	30.1	2173	Clev, Del	148.0	Ramkumar...[1-25]	
672	100 RT	0.00	5237	98.20	139.0	16.4	23.3	14.0	3246	Bear, Sp	167.0	Ramkumar...[1-25]	
673	100 RT	0.00	5374	104.37	143.8	17.5	24.1	24.2	3309	Bear, Sp	182.0	Ramkumar...[1-25]	
674	100 RT	0.00	5169	103.17	136.7	17.3	23.0	13.8	3289	Bear, Sp	182.0	Ramkumar...[1-25]	
675	100 RT	0.00	4636	53.25	123.4	8.9	20.6	20.7	2062	Bear, Sp	182.0	Ramkumar...[1-25]	
676	100 RT	0.00	3488	66.35	92.6	11.1	15.5	15.5	2173	Bear	143.0	Ramkumar...[1-25] Shear head Csk depth = .07"	
677	100 RT	0.00	3278	61.55	87.7	10.3	14.7	14.7	2083	Bolt Tens	114.0	Ramkumar...[1-25] Shear head Csk depth = .07"	
678	100 RT	0.00	4025	52.71	106.1	8.7	17.6	17.6	1476	Shear	185.0	Ramkumar...[1-25]	
679	100 RT	0.00	4128	82.01	108.2	13.8	18.3	18.3	1482	Shear	182.0	Ramkumar...[1-25]	
680	100 RT	0.00	4094	95.54	108.7	16.0	18.2	18.2	1482	Shear, Del	182.0	Ramkumar...[1-25]	
681	100 RT	0.00	5241	111.72	142.8	18.5	23.7	23.7	3279	Bear, Sp	187.0	Ramkumar...[1-25]	
682	100 RT	0.00	5139	103.17	136.0	17.3	22.8	22.8	3216	Bear, Sp	171.0	Ramkumar...[1-25]	
683	100 RT	0.00	5071	94.57	137.0	15.7	22.7	22.7	3280	Bear, Sp	167.0	Ramkumar...[1-25]	
684	100 RT	0.00	2951	33.16	81.5	16.5	40.6	13.6	3859	Tens	70.0	Ramkumar...[1-25]	
685	100 RT	0.00	2785	70.03	75.0	35.0	37.4	12.4	3694	Tens	87.0	Ramkumar...[1-25]	
686	100 RT	0.00	2633	28.18	79.8	14.1	40.0	13.4	3682	Tens	75.0	Ramkumar...[1-25]	
687	100 RT	0.00	4406	82.38	117.1	20.5	29.2	19.4	2917	Del	148.0	Ramkumar...[1-25]	
688	100 RT	0.00	4612	69.08	127.4	17.2	31.8	21.2	3227	Clev	162.0	Ramkumar...[1-25]	
689	100 RT	0.00	4783	94.27	126.8	23.5	32.2	21.4	3153	Tens, Del	143.0	Ramkumar...[1-25]	
690	100 RT	0.00	4773	82.80	127.5	10.3	15.9	21.2	21.3	Unknown	222.0	Ramkumar...[1-25]	
691	100 RT	0.00	4577	91.58	123.3	11.4	15.4	20.5	1666	Shear, Del	200.0	Ramkumar...[1-25]	
692	100 RT	0.00	4783	76.05	129.9	9.5	16.2	21.6	1688	Shear, Del	210.0	Ramkumar...[1-25]	
693	100 RT	0.00	4358	31.75	115.3	5.3	19.4	19.4	1902	Sher, Cle	181.0	Ramkumar...[1-25]	
694	100 RT	0.00	4690	46.13	127.3	7.7	21.3	21.4	21.3	Unknown	222.0	Ramkumar...[1-25]	
695	100 RT	0.00	4138	56.51	116.9	9.5	19.7	19.7	1862	Sh.Cle, Del	200.0	Ramkumar...[1-25]	
696	100 RT	0.00	3556	41.05	97.3	6.9	16.3	16.3	1637	Bear	186.0	Ramkumar...[1-25]	
697	100 RT	0.00	3595	53.55	101.3	9.0	17.0	17.0	1624	Bear	186.0	Ramkumar...[1-25]	
698	100 RT	0.00	3254	68.49	89.1	34.1	44.4	44.4	3298	Tens	99.0	Ramkumar...[1-25]	
699	100 RT	0.00	3185	68.71	87.5	34.2	43.8	43.8	3330	Clev	100.0	Ramkumar...[1-25]	
700	100 RT	0.00	3131	65.19	85.0	32.5	42.4	41.1	3135	Tens	114.0	Ramkumar...[1-25]	

## Single J-Tension

A	B	C	D	E	F	G	H	I	J	K	L
701 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.250	0.119	0.312	0.939	4.01	3.01	Singl8	0.313	St Pr. head 51B464-SAB
702 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.252	0.119	0.312	0.931	4.01	2.98	Singl8	0.313	St Pr. head 51B464-SAB
703 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.250	0.120	0.312	0.944	4.01	3.03	Singl8	0.313	St Pr. head 51B464-SAB
704 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	2.500	0.123	0.311	0.932	8.04	3.00	Singl8	0.313	St Pr. head 51B464-SAB
705 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	2.500	0.121	0.312	0.939	8.01	3.01	Singl8	0.313	St Pr. head 51B464-SAB
706 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	2.502	0.120	0.311	0.937	8.05	3.01	Singl8	0.313	St Pr. head 51B464-SAB
707 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.881	0.121	0.312	0.931	6.03	2.98	Singl8	0.313	St Csk-T 51B335-9
708 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.878	0.120	0.311	0.931	6.04	2.99	Singl8	0.313	St Csk-T 51B335-9
709 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.878	0.118	0.312	0.936	6.02	3.00	Singl8	0.313	St Csk-T 51B335-9
710 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.881	0.120	0.311	0.936	6.05	3.01	Singl8	0.313	Ti Csk-T NAS1155VB
711 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.879	0.119	0.312	0.931	6.02	2.98	Singl8	0.313	Ti Csk-T NAS1155VB
712 AS1/3501-6	70/20/10	[45/0/-45/(0/3/90/(0)3]S	1.879	0.119	0.311	0.933	6.04	3.00	Singl8	0.313	Ti Csk-T NAS1155VB
713 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	0.626	0.120	0.312	0.938	2.01	3.01	Singl8	0.313	St Pr. head 51B464-SAB
714 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	0.626	0.118	0.312	0.939	2.01	3.01	Singl8	0.313	St Pr. head 51B464-SAB
715 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.250	0.118	0.312	0.937	4.01	3.00	Singl8	0.313	St Pr. head 51B464-SAB
716 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.251	0.118	0.312	0.938	4.01	3.01	Singl8	0.313	St Pr. head 51B464-SAB
717 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.250	0.120	0.312	0.940	4.01	3.01	Singl8	0.313	St Pr. head 51B464-SAB
718 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	2.500	0.113	0.311	0.938	8.04	3.02	Singl8	0.313	St Pr. head 51B464-SAB
719 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	2.500	0.117	0.311	0.939	8.04	3.02	Singl8	0.313	St Pr. head 51B464-SAB
720 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	2.500	0.116	0.313	0.932	7.99	2.98	Singl8	0.313	St Pr. head 51B464-SAB
721 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.878	0.115	0.314	0.938	5.98	2.95	Singl8	0.313	St Pr. head 51B464-SAB
722 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.879	0.115	0.313	0.937	5.99	2.95	Singl8	0.313	St Pr. head 51B464-SAB
723 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.877	0.115	0.313	0.932	6.00	2.98	Singl8	0.313	St Pr. head 51B464-SAB
724 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.876	0.116	0.312	0.930	6.02	2.98	Singl8	0.313	St Pr. head 51B464-SAB
725 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.878	0.117	0.312	0.929	6.02	2.98	Singl8	0.313	St Csk-T NAS1155VB
726 AS1/3501-6	30/60/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.877	0.115	0.311	0.931	6.04	2.99	Singl8	0.313	St Csk-T NAS1155VB
727 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.118	0.311	1.039	6.03	3.34	Singl8	0.313	St Csk-T 51B335-9
728 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.876	0.116	0.314	0.937	5.97	2.98	Singl8	0.313	St Pr. head 51B464-SAB
729 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.121	0.314	0.942	5.97	3.00	Singl8	0.313	St Pr. head 51B464-SAB
730 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.876	0.120	0.314	0.935	5.97	2.98	Singl8	0.313	St Pr. head 51B464-SAB
731 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.120	0.315	0.939	5.95	2.98	Singl8	0.313	St Fr. head 51B464-SAB
732 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.118	0.311	0.933	6.03	3.00	Singl8	0.313	St Pr. head 51B464-SAB
733 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.876	0.112	0.315	0.941	5.96	2.93	Singl8	0.313	St Pr. head 51B464-SAB
734 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.120	0.315	0.938	5.95	2.98	Singl8	0.313	St Pr. head 51B464-SAB
735 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.120	0.316	0.925	5.95	2.94	Singl8	0.313	St Pr. head 51B464-SAB
736 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.876	0.119	0.314	0.943	5.97	3.00	Singl8	0.313	St Pr. head 51B464-SAB
737 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.876	0.120	0.314	0.937	5.97	2.99	Singl8	0.313	St Pr. head 51B464-SAB
738 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.874	0.119	0.314	0.936	5.97	2.98	Singl8	0.313	St Pr. head 51B464-SAB
739 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.119	0.316	0.943	5.94	2.98	Singl8	0.313	St Fr. head 51B464-SAB
740 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.118	0.314	0.938	5.90	2.95	Singl8	0.313	St Pr. head 51B464-SAB
741 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.877	0.119	0.311	0.938	6.04	3.02	Singl8	0.313	T Csk-S NAS1581IV-5-A
742 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.877	0.119	0.314	0.943	5.98	3.00	Singl8	0.313	T Csk-S NAS1581IV-5-B
743 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.876	0.114	0.315	0.940	5.96	2.93	Singl8	0.313	T Csk-S NAS1581IV-5-C
744 AS1/3501-6	50/40/10	[45/0/-45/(0/45/90/(4/5/-45)]S	1.875	0.113	0.311	0.931	6.03	2.99	Singl8	0.313	St Pr. head 51B464-SAB

## Single J-Tension

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
701	100	RT	0.00	3977	67.33	107.1	16.8	26.7	17.8	20r1 Shear	129.0 Ramkumar...[1-25]		
702	100	RT	0.00	3058	72.72	82.4	18.1	20.5	13.8	1885 Shear	154.0 Ramkumar...[1-25]		
703	120	RT	0.00	4128	96.15	110.3	24.0	27.5	18.2	2183 Shear	200.0 Ramkumar...[1-25]		
704	100	RT	0.00	3889	67.97	101.7	8.5	12.6	17.0	1144 Shear	190.0 Ramkumar...[1-25]		
705	100	RT	0.00	4025	68.87	106.6	8.6	13.3	17.7	1239 Shear	214.0 Ramkumar...[1-25]		
706	100	RT	0.00	4221	80.39	113.1	10.0	14.1	18.8	1241 Shear	200.0 Ramkumar...[1-25]		
707	100	218	1.094	2853	58.28	75.6	9.7	12.5	12.7	1032 Clev. Del	71.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
708	100	218	1.094	2814	61.63	75.4	10.2	12.5	12.6	1085 Shear	64.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
709	100	218	1.094	3063	57.04	83.2	9.5	13.8	13.9	1144 Shear	73.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
710	100	218	1.094	3063	40.19	82.1	6.6	13.6	13.6	1144 Ten-Clev	77.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
711	100	218	1.094	2745	53.87	73.9	8.9	12.3	12.4	1013 Ten-Clev	70.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
712	100	218	1.094	2750	35.42	74.9	5.9	12.4	12.5	1044 Ten-Clev	80.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
713	100	RT	0.00	2203	58.76	58.8	29.3	29.3	9.8	4086 Tens	74.0 Ramkumar...[1-25]		
714	100	RT	0.00	2208	57.04	60.0	28.4	29.9	10.0	4160 Tens	62.0 Ramkumar...[1-25]		
715	100	RT	0.00	5120	105.93	139.1	26.4	34.7	23.2	4728 Bear. Spil	63.0 Ramkumar...[1-25]		
716	100	RT	0.00	4675	100.50	127.0	25.1	31.7	21.1	4405 Bear. Spil	130.0 Ramkumar...[1-25]		
717	100	RT	0.00	4866	98.82	130.0	24.7	32.4	21.6	4444 Bear. Spil	138.0 Ramkumar...[1-25]		
718	100	RT	0.00	5129	99.79	142.2	12.4	17.7	23.6	2522 Bear. Spil	188.0 Ramkumar...[1-25]		
719	100	RT	0.00	4748	93.44	130.5	11.6	16.2	21.6	2224 Bear. Spil	182.0 Ramkumar...[1-25]		
720	100	RT	0.00	4768	55.08	131.3	6.9	16.4	22.1	2319 Bear. Spil	190.0 Ramkumar...[1-25]		
721	100	218	0.908	4255	58.16	117.8	9.7	19.7	19.7	2318 Bear. Spil	80.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
722	100	218	0.908	3908	61.12	108.6	10.2	18.1	18.1	2649 Bear. Spil	75.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
723	100	218	0.908	3830	47.23	106.4	7.9	17.7	17.9	2567 Bear. Spil	75.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
724	100	218	0.908	4030	80.13	111.4	13.3	18.5	18.7	2620 Bear. Spil	74.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
725	100	218	0.908	3981	63.01	109.1	10.5	16.1	16.3	2955 Bear. Spil	71.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
726	100	218	0.908	4475	64.31	125.1	10.7	20.7	20.9	3031 Bear. Spil	86.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
727	0	RT	0.00	4851	89.92	132.2	14.9	21.9	19.8	2229 Sh.CI.Spi	185.0 Ramkumar...[1-25]		
728	0	RT	0.00	4529	81.59	119.2	13.7	20.0	20.0	2044 Bear	167.0 Ramkumar...[1-25]		
729	0	RT	0.00	4846	78.96	127.5	13.2	21.4	21.3	2210 Del.BI.CI	184.0 Ramkumar...[1-25]		
730	50	RT	0.00	4494	84.93	119.3	14.2	20.0	20.0	2076 Sh.Sp	143.0 Ramkumar...[1-25]		
731	50	RT	0.00	4650	76.72	123.0	12.9	20.7	20.6	2060 Del.CI.BR	174.0 Ramkumar...[1-25]		
732	50	RT	0.00	4670	78.27	126.0	13.1	21.1	21.0	2150 Sh.Del	176.0 Ramkumar...[1-25]		
733	150	RT	0.00	5266	116.21	149.3	19.5	25.1	25.0	2325 Sh.Del	200.0 Ramkumar...[1-25]		
734	150	RT	0.00	4700	100.53	124.3	16.9	20.9	20.9	2102 Sh.CI.Sp	222.0 Ramkumar...[1-25]		
735	150	RT	0.00	4836	97.88	127.9	16.4	21.5	21.6	2158 Del.CI	185.0 Ramkumar...[1-25]		
736	200	RT	0.00	5002	102.68	135.2	17.0	22.4	22.5	2307 Br.Sp	180.0 Ramkumar...[1-25]		
737	200	RT	0.00	4758	100.85	126.3	16.9	21.1	21.2	2094 Sh.Sp	194.0 Ramkumar...[1-25]		
738	200	RT	0.00	4831		129.3		21.7	21.7	2180 Sher	Ramkumar...[1-25]		
739	100	RT	0.00	4221	79.78	112.2	13.4	18.9	18.8	1910 Sh.Del	75.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
740	100	RT	0.00	3752	71.72	103.5	12.2	17.6	17.5	1680 Bolt Tens	Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
741	100	RT	0.00	3210	70.25	86.7	11.8	14.4	14.4	1512 Bear	143.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
742	100	RT	0.00	3146	69.58	84.2	11.8	14.1	14.0	1438 Bear	133.0 Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
743	100	RT	0.00	3097	72.40	86.2	12.2	14.5	14.5	1435 Split	Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	
744	100	RT	0.00	4719	85.37	134.3	14.2	22.3	22.4	2160 Shear	Ramkumar...[1-25]	Si Ten. head Csk depth = 10 <sup>r</sup>	

## Single J-Tension

A	B	C	D	E	F	G	H	I	J	K	L
745 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.114	0.934	6.03	3.00	Single	0.313	St Pr. head	51B464-5A8
746 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.117	0.931	6.03	3.04	Single	0.313	St Pr. head	51B464-5A8
747 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/015]s	1.876	0.120	0.932	6.01	3.00	Single	0.313	St Pr. head	51B464-5A8
748 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/015]s	1.875	0.120	0.932	6.01	3.01	Single	0.313	St Pr. head	51B464-5A8
749 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/015]s	1.876	0.119	0.932	6.01	3.02	Single	0.313	St Pr. head	51B464-5A8
750 AS1/3501-6	70/20/10	[(0)3/±4.5/(0)4/90]s	1.877	0.118	0.931	6.04	3.01	Single	0.313	St Pr. head	51B464-5A8
751 AS1/3501-6	70/20/10	[(0)3/±4.5/(0)4/90]s	1.875	0.117	0.931	6.03	3.01	Single	0.313	St Pr. head	51B464-5A8
752 AS1/3501-6	70/20/10	[(0)3/±4.5/(0)4/90]s	1.878	0.115	0.931	6.04	3.00	Single	0.313	St Pr. head	51B464-5A8
753 AS1/3501-6	70/20/10	[(0)3/±4.5/(0)4/45]0s	1.875	0.120	0.931	6.03	3.01	Single	0.313	St Pr. head	51B464-5A8
754 AS1/3501-6	70/20/10	[(0)3/±4.5/(0)4/45]0s	1.876	0.120	0.931	6.03	3.01	Single	0.313	St Pr. head	51B464-5A8
755 AS1/3501-6	70/20/10	[(0)3/±4.5/(0)4/45]0s	1.875	0.120	0.931	6.03	3.01	Single	0.313	St Pr. head	51B464-5A8
756 AS1/3501-6	30/60/10	[(±4.5)3/(0)3/90]s	1.878	0.117	0.932	6.02	3.04	Single	0.313	St Pr. head	51B464-5A8
757 AS1/3501-6	30/60/10	[(±4.5)3/(0)3/90]s	1.875	0.117	0.932	6.01	3.02	Single	0.313	St Pr. head	51B464-5A8
758 AS1/3501-6	30/60/10	[(±4.5)3/(0)3/90]s	1.878	0.117	0.932	6.01	3.00	Single	0.313	St Pr. head	51B464-5A8
759 AS1/3501-6	30/60/10	[(0)±4.5/0/±4.5/90/±45]0s	1.876	0.120	0.932	6.01	3.00	Single	0.313	St Pr. head	51B464-5A8
760 AS1/3501-6	30/60/10	[(0)±4.5/0/±4.5/90/±45]0s	1.876	0.120	0.932	6.01	3.00	Single	0.313	St Pr. head	51B464-5A8
761 AS1/3501-6	30/80/10	[(0)±4.5/0/±4.5/90/±45]0s	1.875	0.120	0.932	6.01	3.00	Single	0.313	St Pr. head	51B464-5A8
762 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.115	0.931	5.97	2.98	Single	0.313	St Cak-T	51B335-9
763 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.116	0.931	5.97	2.98	Single	0.313	St Cak-T	51B335-9
764 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.118	0.931	5.97	2.98	Single	0.313	St Cak-T	51B335-9
765 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/0/90]s	1.877	0.119	0.931	5.94	2.96	Single	0.313	Al Cak-T	HL23-10-8
766 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/0/90]s	1.876	0.119	0.931	5.96	2.98	Single	0.313	Al Cak-T	HL23-10-8
767 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.114	0.931	5.97	2.96	Single	0.313	Ti Cak-T	NAS1581V5-8
768 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.114	0.931	5.97	2.97	Single	0.313	Ti Cak-T	NAS1581V5-8
769 AS1/3501-6	50/40/10	[(0)3/±4.5/(0)2/±4.5/90]s	1.875	0.118	0.931	5.94	2.96	Single	0.313	Ti Cak-T	NAS1581V5-8
770 AS1/3501-6	50/40/10	[(90)(±4.5)2/0/5]s	1.875	0.120	0.931	5.95	2.98	Single	0.313	Ti Cak-T	NAS1155V8
771 AS1/3501-6	50/40/10	[(90)(±4.5)2/0/5]s	1.875	0.120	0.931	5.97	2.98	Single	0.313	Ti Cak-T	NAS1155V8
772 AS1/3501-6	50/40/10	[(90)(±4.5)2/0/5]s	1.875	0.120	0.931	5.97	3.00	Single	0.313	Ti Cak-T	NAS1155V8
773 AS1/3501-6	70/20/10	[(4.5)/-4.5/(0)3/90/(0)3]s	1.875	0.119	0.931	5.95	2.97	Single	0.313	Ti Cak-T	NAS1155V8
774 AS1/3501-6	70/20/10	[(4.5)/-4.5/(0)3/90/(0)3]s	1.875	0.120	0.931	5.93	2.98	Single	0.313	Ti Cak-T	NAS1155V8
775 AS1/3501-6	70/20/10	[(4.5)/-4.5/(0)3/90/(0)3]s	1.876	0.118	0.931	5.97	2.98	Single	0.313	Ti Cak-T	NAS1155V8
776 AS1/3501-6	30/60/10	[(4.5)/-4.5/(0)45/90/-45/45]s	1.875	0.119	0.931	5.95	2.97	Single	0.313	Ti Cak-T	NAS1155V8
777 AS1/3501-6	30/60/10	[(4.5)/-4.5/(0)45/90/-45/45]s	1.877	0.119	0.931	5.95	2.97	Single	0.313	Ti Cak-T	NAS1155V8
778 AS1/3501-6	30/60/10	[(4.5)/-4.5/0/45/90/-45/45]s	1.876	0.118	0.931	5.93	2.97	Single	0.313	Ti Cak-T	NAS1155V8
779 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/90]s	1.879	0.120	0.931	5.92	2.99	Single	0.313	Ti Cak-T	51B335-9
780 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/90]s	1.878	0.120	0.931	5.96	2.99	Single	0.313	Ti Cak-T	51B335-9
781 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/90]s	1.876	0.120	0.931	5.97	2.91	Single	0.313	Ti Cak-T	51B335-9
782 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/45/90/-45/45]s	1.877	0.118	0.931	5.98	2.98	Single	0.313	Ti Cak-T	NAS1155V8
783 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/90]s	1.879	0.120	0.931	5.98	2.95	Single	0.313	Ti Cak-T	51B335-9
784 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/90]s	1.879	0.120	0.931	5.98	2.91	Single	0.313	Ti Cak-T	51B335-9
785 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/90]s	1.876	0.120	0.931	5.96	2.97	Single	0.313	Ti Cak-T	51B335-9
786 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/0/90]s	1.877	0.118	0.931	5.98	2.91	Single	0.313	Ti Cak-T	51B335-9
787 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/0/90]s	1.876	0.118	0.931	5.98	2.98	Single	0.750	St Pr. Hd	51B464-12A18
788 AS1/3501-6	50/40/10	[(4.5)/-4.5/0/2/0/90]s	1.877	0.117	0.931	5.99	2.97	Single	0.750	St Pr. Hd	51B464-12A18

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
745	100	RT	0.00	4509	81.80	127.2	13.6	21.1	21.2	2020	Sh, Sp	185.0	Ramkumar...[1-25]	
746	100	RT	0.00	4812	52.22	132.2	8.7	21.9	21.7	2206	Shear	185.0	Ramkumar...[1-25]	
747	100	RT	0.00	4640	80.13	123.9	13.3	20.6	20.6	2144	Sh,Br,Sp	188.0	Ramkumar...[1-25]	
748	100	RT	0.00	4650	80.13	124.2	13.3	20.7	20.7	2044	Sh,Br,Sp	182.0	Ramkumar...[1-25]	
749	100	RT	0.00	4568		123.0		20.5	20.4	2118	Sh,Br,Sp		Ramkumar...[1-25]	
750	100	RT	0.00	4026		76.30	109.7	12.6	18.2	1562	Shear		Ramkumar...[1-25]	
751	100	RT	0.00	4074		76.95	112.0	12.8	18.6	1527	Shear	182.0	Ramkumar...[1-25]	
752	100	RT	0.00	4030		44.74	112.7	7.4	18.7	1512	Shear	240.0	Ramkumar...[1-25]	
753	100	RT	0.00	3962		75.03	106.2	12.4	17.6	1492	Shear		Ramkumar...[1-25]	
754	100	RT	0.00	3874		64.31	103.8	10.7	17.2	1431	Shear	222.0	Ramkumar...[1-25]	
755	100	RT	0.00	3810		69.67	102.1	11.6	16.9	17.0	1408	Shear	211.0	Ramkumar...[1-25]
756	100	RT	0.00	4934		95.88	135.2	15.9	22.5	22.3	3134	Br, Sp	210.0	Ramkumar...[1-25]
757	100	RT	0.00	4899		90.40	134.2	15.0	22.3	22.2	3126	Br, Sp	174.0	Ramkumar...[1-25]
758	100	RT	0.00	4856		87.66	133.0	14.6	22.1	22.1	3163	Br, Sp	171.0	Ramkumar...[1-25]
759	100	RT	0.00	5193		98.82	138.7	16.4	23.1	23.1	3341	Br, Sp	200.0	Ramkumar...[1-25]
760	100	RT	0.00	5164		88.14	137.9	14.7	22.9	23.0	3358	Br, Sp	200.0	Ramkumar...[1-25]
761	100	RT	0.00	5110		98.82	136.5	16.4	22.7	22.7	3260	Br, Sp	185.0	Ramkumar...[1-25]
762	100	RT	0.00	4284		72.00	118.6	12.1	19.9	19.9	1954	Shear	88.0	Ramkumar...[1-25]
763	100	RT	0.00	3928		79.62	107.8	13.3	18.1	18.1	1790	Sh,Br,Sp	108.0	Ramkumar...[1-25]
764	100	RT	0.00	4265		86.37	115.1	14.5	19.3	2022	Ci,Del	83.0	Ramkumar...[1-25]	
765	100	RT	0.00	2745		26.59	73.0	4.5	12.3	12.3	1205	Bolt Ten		Ramkumar...[1-25]
766	100	RT	0.00	4250		26.68	113.4	4.5	19.0	19.0	1876	Del,Ci,		Ramkumar...[1-25]
767	100	RT	0.00	3947		78.22	110.3	13.1	18.5	18.6	1827	Br, Sp		Ramkumar...[1-25]
768	100	RT	0.00	4318		75.43	120.6	12.6	20.2	20.3	2004	Sh, Sp	75.0	Ramkumar...[1-25]
769	100	RT	0.00	4069		64.77	109.8	10.8	18.4	18.3	350	Sh, Sp	82.0	Ramkumar...[1-25]
770	100	RT	0.00	3815		47.62	100.9	8.0	17.0	16.9	1748	Sh,Br,Ci	80.0	Ramkumar...[1-25]
771	100	RT	0.00	3937		53.08	104.5	8.9	17.5	17.5	1771	Sh,Br,Ci	83.0	Ramkumar...[1-25]
772	100	RT	0.00	3771		58.39	100.1	9.8	16.8	16.7	1701	Sh,Br,Ci	83.0	Ramkumar...[1-25]
773	100	RT	0.00	3195		48.02	85.2	8.1	14.3	14.3	1100	Shear	70.0	Ramkumar...[1-25]
774	100	RT	0.00	3293		42.19	86.8	7.1	14.6	14.7	1171	Shear	81.0	Ramkumar...[1-25]
775	100	RT	0.00	3478		84.77	93.5	10.8	15.7	15.7	1234	Sh, Ci	100.0	Ramkumar...[1-25]
776	100	RT	0.00	4035		74.70	107.6	12.5	18.1	18.1	Unknown	Bear	105.0	Ramkumar...[1-25]
777	100	RT	0.00	4055		69.36	108.2	11.6	18.2	18.2	2529	Bolt Ten	75.0	Ramkumar...[1-25]
778	100	RT	0.00	4323		116.3			19.5	19.5	2757	Bolt Ten	75.0	Ramkumar...[1-25]
779	100	RT	0.996	3595		79.98	92.8	13.7	15.9	16.0	1590	Ci, Del		Ramkumar...[1-25]
780	100	RT	0.938	4142		85.94	107.9	14.6	18.4	18.6	1865	Sh, Del	75.0	Ramkumar...[1-25]
781	100	RT	0.978	4103		80.73	108.8	13.8	18.2	18.4	1824	Ci, Del	97.0	Ramkumar...[1-25]
782	100	RT	0.998	4025		108.6			18.2	18.2	1781	Bolt Ten	74.0	Ramkumar...[1-25]
783	100	RT	0.918	0.998	3591	55.73	95.3	9.3	15.9	16.1	1630	Br, Del	171.0	Ramkumar...[1-25]
784	100	RT	0.918	0.998	4016	68.78	106.2	11.5	17.8	18.0	1919	Sh, Del	74.0	Ramkumar...[1-25]
785	100	RT	0.918	0.978	4157	68.78	110.0	11.5	18.5	18.5	1909	Clev	79.0	Ramkumar...[1-25]
786	100	RT	0.00	24231		39.11	90.2	6.5	15.0	15.0	1805	Sh, Del	75.0	Ramkumar...[1-25]
787	100	RT	0.00	22716		44.82	84.8	7.5	14.1	14.2	1639	Sh, Del	630.0	Ramkumar...[1-25]
788	100	RT	0.00	23498		40.28	87.6	6.7	14.6	14.7	1811	Sh, Del		Ramkumar...[1-25]

A	B	C	D	E	F	G	H	I	J	K	L
789 AS1/3501-6	70/20/10	(45/0/-45/(0)3 90/(0)3 3s	4.500	0.355	0.750	2.258	6.00	3.01	Single	0.750	St. Pr. Hd 5IB464-12A18
790 AS1/3501-6	70/20/10	(45/0/-45/(0)3 90/(0)3 3s	4.500	0.358	0.750	2.245	6.00	2.99	Single	0.750	St. Pr. Hd 5IB464-12A18
791 AS1/3501-6	70/20/10	(45/0/-45/(0)3 90/(0)3 3s	4.500	0.352	0.750	2.242	6.00	2.99	Single	0.750	St. Pr. Hd 5IB464-12A18
792 AS1/3501-6	30/60/10	((45/0/-45/(0)45/90/-45/(0)45/-45)s	3.000	0.229	0.500	1.484	6.00	2.97	Single	0.750	St. Csk. T 5IB338-18
793 AS1/3501-6	30/60/10	((45/0/-45/(0)45/90/-45/(0)45/-45)s	4.499	0.342	0.750	2.251	6.00	3.00	Single	0.750	St. Pr. Hd 5IB464-12A18
794 AS1/3501-6	30/60/10	((45/0/-45/(0)45/90/-45/(0)45/-45)s	4.499	0.344	0.751	2.254	5.99	3.00	Single	0.750	St. Pr. Hd 5IB464-12A18
795 AS1/3501-6	30/60/10	((45/0/-45/(0)45/90/-45/(0)45/-45)s	4.499	0.344	0.752	2.249	5.98	2.99	Single	0.750	St. Pr. Hd 5IB464-12A18
796 AS1/3501-6	50/40/10	((45/0/-45/(0)2/0/90)s	1.877	0.118	0.312	0.937	6.02	3.00	Double	0.313	St. Pr. head 5IB464-5AB
797 AS1/3501-6	50/40/10	((45/0/-45/(0)2/0/90)s	1.875	0.119	0.311	0.929	6.03	2.99	Double	0.313	St. Pr. head 5IB464-5AB
798 AS1/3501-6	50/40/10	((45/0/-45/(0)2/0/90)s	1.875	0.117	0.312	0.931	6.01	2.98	Double	0.313	St. Pr. head 5IB464-5AB
799 AS1/3501-6	70/20/10	(45/0/-45/(0)3 90/(0)3 s	1.875	0.120	0.311	0.935	6.03	3.01	Double	0.313	St. Pr. head 5IB464-5AB
800 AS1/3501-6	70/20/10	(45/0/-45/(0)3 90/(0)3 s	1.875	0.120	0.311	0.935	6.03	3.01	Double	0.313	St. Pr. head 5IB464-5AB
801 AS1/3501-6	70/20/10	(45/0/-45/(0)3 90/(0)3 s	1.877	0.123	0.311	0.937	6.04	3.01	Double	0.313	St. Pr. head 5IB464-5AB
802 AS1/3501-6	30/60/10	(45/0/-45/(0)45/90/-45/(0)45/-45)s	1.874	0.119	0.311	0.936	6.03	3.01	Double	0.313	St. Pr. head 5IB464-5AB
803 AS1/3501-6	30/60/10	(45/0/-45/(0)45/90/-45/(0)45/-45)s	1.875	0.118	0.311	0.932	6.03	3.00	Double	0.313	St. Pr. head 5IB464-5AB
804 AS1/3501-6	30/60/10	(45/0/-45/(0)45/90/-45/(0)45/-45)s	1.878	0.115	0.310	0.936	6.06	3.02	Double	0.313	St. Pr. head 5IB464-5AB

## Single J-Tension

M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
789	100 RT	0.00	300444	67.61	112.8	11.3	18.8	18.7	2289	Sh. Del	530.0	Ramkumar...[1-25]	
790	100 RT	0.00	26185	97.5			16.3	16.3	2064	Del		Ramkumar...[1-25]	
791	100 RT	0.00	29287	57.58	110.8	9.6	18.5	18.6	2251	Sh. Del		Ramkumar...[1-25]	
792	100 RT	0.00	13854	54.15	119.2	9.0	19.9	20.1	2640	Bolt Ten	600.0	Ramkumar...[1-25] Si Ten. head Csk depth = 20	
793	100 RT	0.00	31192		121.8		20.3	20.3	3458	Br. Sp		Ramkumar...[1-25]	
794	100 RT	0.00	32482	53.42	125.7	8.9	21.0	20.9	3041			Ramkumar...[1-25]	
795	100 RT	0.00	31998		123.7		20.7	20.7	3307	Br. Sp	58.0	Ramkumar...[1-25]	
796	100 RT	0.00	4778	129.8			21.6	21.6	2108	Del	92.0	Ramkumar...[1-25]	
797	100 RT	0.00	4577	89.17	123.7	14.8	20.5	20.7	2168	Ten-clv		Ramkumar...[1-25]	
798	100 RT	0.00	4890	87.66	134.0	14.6	22.3	22.4	2217	Del	263.0	Ramkumar...[1-25]	
799	100 RT	0.00	4055	50.91	108.7	8.4	18.0	18.1	1540	Del. Sp	240.0	Ramkumar...[1-25]	
800	100 RT	0.00	3747	53.59	100.4	8.9	16.7	16.7	1398	Sher	263.0	Ramkumar...[1-25]	
801	100 RT	0.00	4133	78.43	108.0	13.0	17.9	17.9	1461	Sher	205.0	Ramkumar...[1-25]	
802	100 RT	0.00	5857	102.68	158.3	17.0	26.3	26.3	3708	Del	273.0	Ramkumar...[1-25]	
803	100 RT	0.00	6323	122.62	172.3	20.3	28.6	28.7	4027	Br. Del	218.0	Ramkumar...[1-25]	
804	100 RT	0.00	5721	103.79	160.5	17.1	26.5	26.6	3617	Bear	242.0	Ramkumar...[1-25]	

**Appendix 1-2. Data for single bolted-joints under  
bearing/bypass loading.**

## Bearing/Bypass

A	B	C	D	E	F	G	H	I	J	K	L	M
Material	Percent of 0±45/90	Stacking Sequence	Plate Width W (in.)	Plate Thickness t (in.)	Plate Width d (in.)	Joint Type	Fastener Diameter d' (in.)	Fastener Type	Fastener Type	Fastener Type	Fastener Type	Bearing/ Total Load Ratio
1	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.876	0.120	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.167
2	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.118	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0
3	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.874	0.120	6.05	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0
4	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.874	0.117	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.167
5	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.118	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0
6	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.120	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0
7	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.117	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.167
8	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.120	6.07	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.167
9	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.117	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.167
10	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.874	0.119	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.167
11	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.121	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.287
12	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.876	0.115	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.287
13	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.118	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.287
14	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.118	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.375
15	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/0/90]S	1.875	0.118	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0.375
16	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.875	0.120	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0
17	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.876	0.119	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0
18	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.875	0.120	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Tens	0
19	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.875	0.120	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.167
20	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.874	0.119	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.167
21	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.876	0.118	6.03	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.167
22	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.875	0.119	6.03	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.287
23	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.873	0.119	6.00	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.287
24	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.875	0.118	6.03	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.287
25	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.875	0.117	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.375
26	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.875	0.118	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.375
27	AS1/3501-6	70/20/10	[(45/0/-45/0)/3/90]/0/3/S	1.876	0.118	6.03	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0.375
28	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.875	0.114	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0
29	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.875	0.119	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0
30	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.874	0.119	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0
31	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.876	0.115	6.01	Single	0.312	Si	Csk-T 51B335-9	100 Bo, Sp-Tens	0
32	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.873	0.115	6.00	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.167
33	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.875	0.117	6.01	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.167
34	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.873	0.115	6.03	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.287
35	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.873	0.115	6.07	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.287
36	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.876	0.117	6.03	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.287
37	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.873	0.115	6.01	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.375
38	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.873	0.115	6.03	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.375
39	AS1/3501-6	30/60/10	[(5/0/-45/0)/45/90/-45/0/±45]S	1.874	0.117	6.03	Single	0.312	Ti	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.375
40	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.874	0.121	6.01	Single	0.312	Si	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0
41	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.875	0.119	6.01	Single	0.312	Si	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0
42	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.875	0.119	6.03	Single	0.312	Si	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0
43	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.875	0.119	6.01	Single	0.312	Si	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.2
44	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.975	0.12	6.03	Single	0.312	Si	Csk-S NAS1581V5-8	100 Bo, Sp-Tens	0.2
45	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.876	0.118	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Camp	0
46	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.873	0.121	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Camp	0.2
47	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.874	0.118	6.01	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Camp	0.33
48	AS1/3501-6	50/40/10	[(45/0/-45/0)/2/90]S	1.875	0.118	6.03	Single	0.312	Si	Pr head 51B464-5A8	100 Bo, Sp-Camp	0.33

N	P	Q	R	S	T	U	V	W	X	Y	Z
1	Test	Moisture	Failing	Bearing	Gross Strength	Gross	Remote	Mode	Joint	Reference	Remarks
2	Tempo-Content	Load.	(Initial)	Non-Strength	(Initial Non-Strength)	Failure	Strain	of	Stiffness		Initial Nonlinear Load (kips)
3	(°F) (% by Wt)	P(lb.) (lb.)	(linearity)	ksi (P(b)/d)	ksi (linearity)	ksi (P(T)/Wt)	ksi (10E-6)	(in/in)	Failure	(kips/in.)	
4	RT	0.00	13190	0.0	0.0	58.6	5598	Tens	Ramkumar...[1-25]		
5	RT	0.00	12335	0.0	0.0	55.8	5200	Tens	Ramkumar...[1-25]	Open Hole	
6	RT	0.00	13161	0.0	0.0	58.5	5561	Tens	Ramkumar...[1-25]	Open Hole	
7	RT	0.00	10318	22.9	47.4	22.8	47.1	4418	Tens	522 Ramkumar...[1-25]	
8	RT	0.00	11197	24.3	50.4	24.0	49.8	4638	Tens	552 Ramkumar...[1-25]	5.0
9	RT	0.00	10533	34.8	48.2	34.6	48.0	4283	Tens	545 Ramkumar...[1-25]	5.4
10	RT	0.00	10454	44.1	80.8	25.6	46.9	2813	Ten, Del	470 Ramkumar...[1-25]	7.6
11	RT	0.00	9858	68.6	75.2	39.7	43.5	4088	Tens	444 Ramkumar...[1-25]	5.7
12	RT	0.00	9936	36.1	79.7	20.9	46.1	4354	Tens	488 Ramkumar...[1-25]	9.0
13	RT	0.00	9643	36.8	98.5	16.3	43.6	3968	Tens	455 Ramkumar...[1-25]	4.5
14	RT	0.00	9340	41.9	95.4	18.5	42.2	3974	Tens	345 Ramkumar...[1-25]	3.6
15	RT	0.00	9341	71.3	95.1	31.6	42.2	3755	Tens	417 Ramkumar...[1-25]	4.1
16	RT	0.00	20225	0.0	0.0	89.9	6417	Tens	Ramkumar...[1-25]	Open Hole	7.0
17	RT	0.00	19404	0.0	0.0	86.9	6196	Del	Ramkumar...[1-25]	Open Hole	
18	RT	0.00	22789	0.0	0.0	101.3	7180	Tens	Ramkumar...[1-25]	Open Hole	
19	RT	0.00	15730	29.4	70.2	29.3	69.9	3554	Te,Del,Ci	760 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10
20	RT	0.00	17567	17.1	79.0	17.0	78.8	4228	Te, Ci	Ramkumar...[1-25]	Si, Ten, head Csk depth = 10
21	RT	0.00	14382	26.8	65.5	26.7	65.0	1900	De, Ci	445 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10
22	RT	0.00	12907	27.8	99.8	16.1	57.8	1223	Te, Ci	583 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10
23	RT	0.00	11510	25.5	89.0	14.8	51.6	3261	Te,Del,Ci	462 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10
24	RT	0.00	13483	26.6	105.4	15.4	60.9	1796	Te,Del,Ci	541 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10
25	RT	0.00	11797	48.3	121.2	21.4	53.8	Br, Sp	553 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10	
26	RT	0.00	12433	34.6	126.6	15.4	56.2	2018	Br, Sp	467 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10
27	RT	0.00	10620	20.4	108.5	0.0	48.0	Br, Sp	522 Ramkumar...[1-25]	Si, Ten, head Csk depth = 10	
28	RT	0.00	9697	0.0	0.0	45.4	5953	Tens	Ramkumar...[1-25]	Open Hole	
29	RT	0.00	10708	0.0	0.0	48.0	6440	Tens	Ramkumar...[1-25]	Open Hole	
30	RT	0.00	10454	0.0	0.0	46.9			Ramkumar...[1-25]	Open Hole	
31	RT	0.00	9311	11.6	43.3	11.6	43.2	5554	Tens	667 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
32	RT	0.00	9115	18.2	42.4	16.1	42.3	6605	Tens	406 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
33	RT	0.00	8823	40.4	40.2	5214	Tens	5214	Tens	Ramkumar...[1-25]	Si, Shr, head Csk dept.=.07
34	RT	0.00	8988	41.6	71.9	24.1	41.7	5405	Tens	335 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
35	RT	0.00	9233	52.8	73.9	30.6	42.9	5604	Tens	278 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
36	RT	0.00	9105	47.2	71.6	27.3	41.5	7673	Tens	307 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
37	RT	0.00	8622	60.6	90.1	26.9	40.0	5120	Tens	384 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
38	RT	0.00	8402	52.3	87.8	23.2	39.0	4910	Tens	267 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
39	RT	0.00	8862	54.4	91.0	24.2	40.4	5262	Tens	335 Ramkumar...[1-25]	Si, Shr, head Csk depth = .07
40	RT	0.00	13508	0.0	0.0	-59.6	-6593	Comp	Ramkumar...[1-25]	Open Hole	
41	RT	0.00	13522	0.0	0.0	-60.6	-5861	Comp	Ramkumar...[1-25]	Open Hole	
42	RT	0.00	13141	0.0	0.0	-58.9	-6250	Comp	Ramkumar...[1-25]	Open Hole	
43	RT	0.00	-16190	-36.6	-87.2	-30.5	-72.6	-7713	Oil-Co,Ci	649 Ramkumar...[1-25]	
44	RT	0.00	-14411	-50.2	-77.0	-41.8	-64.0	-6936	Comp	526 Ramkumar...[1-25]	-6.8
45	RT	0.00	-11568	-62.8	-62.8	-52.3	-4428	Comp	Ramkumar...[1-25]	-9.4	
46	RT	0.00	-11510	-37.8	-101.3	-19.0	-50.8	-5171	Comp	533 Ramkumar...[1-25]	-4.3
47	RT	0.00	-11539	-63.1	-104.1	-31.7	-52.2	-5163	Comp	44 Ramkumar...[1-25]	-7.0
48	RT	0.00	-11553	-62.0	-103.9	-31.2	-52.2	-5112	Comp	44 Ramkumar...[1-25]	-6.9

A	B	C	D	E	F	G	H	I	J	K	L	M
49 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.876	0.119	0.311	0.38	Single	0.312				Bo, Sp+Comp	0
50 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.875	0.12	0.311	0.39	Single	0.312				Bo, Sp+Comp	0
51 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.875	0.118	0.312	0.38	Single	0.312				Bo, Sp+Comp	0
52 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.875	0.119	0.314	0.38	Single	0.312				Bo, Sp+Comp	0
53 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.876	0.118	0.313	0.38	Single	0.312	St Csk-T 51B335-9	100	Bo, Sp+Comp	0.2	
54 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.875	0.119	0.313	0.38	Single	0.312	St Csk-T 51B335-9	100	Bo, Sp+Comp	0.2	
55 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.875	0.117	0.312	0.38	Single	0.312	St Csk-T 51B335-9	100	Bo, Sp+Comp	0.2	
56 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.875	0.118	0.314	0.38	Single	0.312	St Csk-T 51B335-9	100	Bo, Sp+Comp	0.33	
57 AS1/3501-6 70/20/10	[45/0/-45/(0)3/90/(0)3]S	1.875	0.119	0.312	0.38	Single	0.312	St Csk-T 51B335-9	100	Bo, Sp+Comp	0.33	
58 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.875	0.115	0.312	0.37	Single	0.312			Bo, Sp+Comp	0	
59 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.873	0.118	0.312	0.38	Single	0.312			Bo, Sp+Comp	0	
60 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.875	0.119	0.312	0.38	Single	0.312			Bo, Sp+Comp	0	
61 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.874	0.114	0.312	0.37	Single	0.312	Ti Csk-S NAS1581V5-8	100	Bo, Sp+Comp	0.2	
62 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.873	0.119	0.311	0.38	Single	0.312	Ti Csk-S NAS1581V5-8	100	Bo, Sp+Comp	0.2	
63 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.876	0.12	0.312	0.38	Single	0.312	Ti Csk-S NAS1581V5-8	100	Bo, Sp+Comp	0.2	
64 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.876	0.113	0.312	0.36	Single	0.312	Ti Csk-S NAS1581V5-8	100	Bo, Sp+Comp	0.33	
65 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.873	0.119	0.312	0.38	Single	0.312	Ti Csk-S NAS1581V5-8	100	Bo, Sp+Comp	0.33	
66 AS1/3501-6 30/60/10	[45/0/-45/(0)45/90/-45/0±45]S	1.872	0.118	0.312	0.38	Single	0.312	Ti Csk-S NAS1581V5-8	100	Bo, Sp+Comp	0.33	
67 T300/N5208 25/50/25	[0/45/90/-45/2]S	1.969 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=0, S=1	0	
68 T300/N5208 25/50/25	[0/45/90/-45]S	1.968 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=1, S=1	0.128	
69 T300/N5208 25/50/25	[0/45/90/-45]S	1.969 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=3, S=1	0.306	
70 T300/N5208 25/50/25	[0/45/90/-45]S	1.969 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=1, S=0	1	
71 T300/N5208 25/50/25	[0/45/90/-45]S	1.968 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=0, S=-1	0	
72 T300/N5208 25/50/25	[0/45/90/-45]S	1.969 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=1, S=-1	-0.172	
73 T300/N5208 25/50/25	[0/45/90/-45]S	1.969 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=3, S=-1	-0.787	
74 T300/N5208 25/50/25	[0/45/90/-45]S	1.969 App.	0.08	0.252	7.81	Single	0.249	Si bolt		B=1, S=0	1	
75 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.10	
76 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.20	
77 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	1.00	
78 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.20	
79 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.20	
80 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	1.00	
81 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.267	
82 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	1.00	
83 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.20	
84 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	1.00	
85 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.133	
86 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.267	
87 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.50	0.12	0.192	7.81	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	1.00	
88 AS1/3501-6 25/50/25	[±45/0/90/1]S	1.125	0.12	0.192	5.86	Single	0.192	Ti 100° Csk-T HL13VAP:		Bo, Sp+Tens	0.40	

Bearing/Bypass

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
49	RTI	0.00	-19922	0.0	0.0	0	-89.2	-7309	Co. Cl	Ramkumar...[1-25]	Open Hole	
50	RTI	0.00	-18857	0.0	0.0	0	-83.8	-7058	Off Comp	Ramkumar...[1-25]	Open Hole	
51	RTI	0.00	-13825	0.0	0.0	0	-62.5	Comp		Ramkumar...[1-25]	Open Hole	
52	RTI	0.00	-16190	-64.2	-86.7	-53.8	-72.6	-5685	Comp	419 Ramkumar...[1-25]		-12.0
53	RTI	0.00	-15710	-85.1		-85.1	-71.0	-5268	Comp	Ramkumar...[1-25]		
54	RTI	0.00	-15183	-40.3	-81.5	-33.6	-68.0	-5306	Comp	Ramkumar...[1-25]		-7.5
55	RTI	0.00	-13219	-73.2	-119.5	-36.9	-61.3	-4436	Br. Sp	368 Ramkumar...[1-25]		-8.1
56	RTI	0.00	-11451	-70.4	-102.0	-35.7	-51.8	-3879	Off Comp	320 Ramkumar...[1-25]		-7.9
57	RTI	0.00	-12450	-110.7		-55.8				Ramkumar...[1-25]		
58	RTI	0.00	-9257	0.0	0.0	0	-42.9	-6031	Comp	Ramkumar...[1-25]	Open Hole	
59	RTI	0.00	-11060	0.0	0.0	0	-50.0	-7682	Comp	Ramkumar...[1-25]	Open Hole	
60	RTI	0.00	-11119	0.0	0.0	0	-49.8	-7623	Off Comp	Ramkumar...[1-25]	Open Hole	
61	RTI	0.00	-9970	-27.0	-56.1	-22.5	-46.7	-6734	Off Comp	357 Ramkumar...[1-25]		
62	RTI	0.00	-11919	-55.1	-64.4	-45.8	-53.5	-8036	Off Comp	326 Ramkumar...[1-25]		-10.2
63	RTI	0.00	-10552	-44.3	-56.4	-36.9	-46.9	-6999	Off Comp	288 Ramkumar...[1-25]		-8.3
64	RTI	0.00	-8304	-61.8	-77.2	-31.1	-39.2	-5357	Bear	253 Ramkumar...[1-5]		-6.6
65	RTI	0.00	-8866	-56.9	-78.8	-28.7	-39.8	-5708	Br. Del.	250 Ramkumar...[1-25]		-6.4
66	RTI	0.00	-8744	-63.6	-78.4	-32.1	-39.6	-5973	Br. Sp	270 Ramkumar...[1-25]		-7.1
67	RTI	Unknown	0	0	31.5	41.7	Unknown	Tens	Unknown	Naik.Crewe.Jr.[1-45]	Open Hole	
68	RTI	Unknown	34.4	36.1	34.4	38.1	Unknown	Tens	Unknown	Naik.Crewe.Jr.[1-45]	Finger light bo., Fit cl = 003*	
69	RTI	Unknown	67.9	94.0	28.4	39.3	Unknown	Tens	Unknown	Naik.Crewe.Jr.[1-45]	Finger light bo., Fit cl = 003*	
70	RTI	Unknown	78.6	117.8	10.1	15.1	Unknown	Bear	Unknown	Naik.Crewe.Jr.[1-45]	Both Loading	
71	RTI	Unknown	0	0	-53.4	-53.4	Unknown	Comp	Unknown	Naik.Crewe.Jr.[1-45]	Open Hole	
72	RTI	Unknown	45.5	66.9	-33.9	-49.8	Unknown	Off-comp	Unknown	Naik.Crewe.Jr.[1-45]	Finger light bo., Fit cl = 003*	
73	RTI	Unknown	72.2	110.1	-11.7	-17.9	Unknown	Off-comp	Unknown	Naik.Crewe.Jr.[1-45]	Finger light bo., Fit cl = 003*	
74	RTI	Unknown	76.6	123.7	9.8	15.8	Unknown	Bear	Unknown	Naik.Crewe.Jr.[1-45]	Both Loading	
75	RTI	0	6624	Unknown	287.5	Unknown	36.8	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
76	RTI	0	6444	Unknown	279.7	Unknown	35.8	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
77	RTI	0	2736	Unknown	118.8	Unknown	15.2	Unknown	Bear	Unknown	Ramkumar [1-41]	Average of 2 specimens.
78	RTI	1.0	6750	Unknown	293.0	Unknown	37.5	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
79	RTI	1.0	6768	Unknown	293.8	Unknown	37.6	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
80	RTI	1.0	2538	Unknown	110.2	Unknown	16.1	Unknown	Bear	Unknown	Ramkumar [1-41]	Average of 2 specimens.
81	RTI	0	7002	Unknown	303.9	Unknown	38.9	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
82	RTI	0	6534	Unknown	283.6	Unknown	35.3	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
83	RTI	0	2916	Unknown	126.6	Unknown	16.2	Unknown	Bear	Unknown	Ramkumar [1-41]	Average of 2 specimens.
84	RTI	0	6102	Unknown	264.8	Unknown	23.9	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
85	RTI	0	5328	Unknown	231.3	Unknown	29.6	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
86	RTI	0	3528	Unknown	153.1	Unknown	19.6	Unknown	Bear	Unknown	Ramkumar [1-41]	Average of 2 specimens.
87	RTI	0	5706	Unknown	247.7	Unknown	31.7	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.
88	RTI	0	4320	Unknown	187.5	Unknown	32	Unknown	Tens	Unknown	Ramkumar [1-41]	Average of 2 specimens.

**Appendix A-3. Data for multiple bolted-joints in composites.**

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
	Param	Cl	Stacking	Plate	Plate	Avg. Hole	End	# of	Pitch	Beck	W/(#C)old	Joint	Fastener	Fastener	
1	Material		Sequence	Width	Thickness	Diameter	Distance	Fastener	Pitch	Ratio	Ratio	Type	Diameter	Type	
2	System	01±45/90		W (in.)	t (in.)	d (in.)	(in.)	Row/Col	L12, L23			0.253	TT bolt	NAS 454-4	
3	Fiber/Resin	plus	[0]45/90/-45/28	0.992	0.181	0.253	1.000	2 x 1	N/A	3.921	3.953	Double	0.254	TT bolt	NAS 454-4
4	T300/N5208	25/150/25	[0]45/90/-45/28	1.004	0.182	0.254	1.000	2 x 1	N/A	3.907	3.937	Double	0.254	TT bolt	NAS 454-4
5	T300/N5208	25/150/25	[0]45/90/-45/28	1.005	0.182	0.257	1.000	2 x 1	N/A	3.957	3.937	Double	0.254	TT bolt	NAS 454-4
6	T300/N5208	25/150/25	[0]45/90/-45/28	1.001	0.183	0.257	1.000	2 x 1	N/A	3.895	3.891	Double	0.257	TT bolt	NAS 454-4
7	T300/N5208	25/150/25	[0]45/90/045/5/45/28	1.002	0.1817	0.256	1.000	2 x 1	N/A	4.006	3.920	Double	0.2506	TT bolt	NAS 454-4
8	T300/N5208	37.5/37.5/25	[0]45/90/045/5/45/50/45/45/50	1.010	0.1658	0.2534	1.000	2 x 1	N/A	3.986	3.945	Double	0.2534	TT bolt	NAS 454-4
9	T300/N5208	37.5/37.5/25	[0]45/90/045/5/45/50/45/45/50	1.007	0.1791	0.2613	1.000	2 x 1	N/A	4.007	3.974	Double	0.2513	TT bolt	NAS 454-4
10	T300/N5208	37.5/37.5/25	[0]45/90/045/5/45/50/45/50/45/50	1.005	0.183	0.2512	1.000	2 x 1	N/A	3.950	3.981	Double	0.2512	TT bolt	NAS 454-4
11	T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.002	0.1676	0.2322	1.000	2 x 1	N/A	3.973	3.965	Double	0.2522	TT bolt	NAS 454-4
12	T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.001	0.1701	0.2518	1.000	2 x 1	N/A	3.979	3.975	Double	0.2516	TT bolt	NAS 454-4
13	T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.000	0.1701	0.2508	1.000	2 x 1	N/A	3.980	3.990	Double	0.2506	TT bolt	NAS 454-4
14	T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.007	0.1791	0.2547	1.000	2 x 1	N/A	3.923	3.896	Double	0.2567	TT bolt	NAS 454-4
15	T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1864	0.2524	1.000	2 x 1	N/A	3.950	3.962	Double	0.2524	TT bolt	NAS 454-4
16	GI/T300/N5208	25/50/25	[0]45/50/045/5/45/50/45/50/45/50	0.926	0.178	0.2524	1.000	2 x 1	N/A	3.939	3.943	Double	0.2536	TT bolt	NAS 454-4
17	GI/T300/N5208	25/50/25	[0]45/90/045/5/45/50/45/50/45/50	0.919	0.1779	0.2536	1.000	2 x 1	N/A	4.015	3.985	Double	0.2503	TT bolt	NAS 454-4
18	GI/T300/N5208	25/50/25	[0]45/90/045/5/45/50/45/50/45/50	1.005	0.1775	0.2503	1.000	2 x 1	N/A	3.979	3.979	Double	0.2513	TT bolt	NAS 454-4
19	GI/T300/N5208	25/50/25	[0]45/90/045/5/45/50/45/50/45/50	1.000	0.177	0.2513	1.000	2 x 1	N/A	3.979	3.978	Double	0.2513	TT bolt	NAS 454-4
20	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1754	0.2515	1.000	2 x 1	N/A	3.950	3.999	Double	0.2505	TT bolt	NAS 454-4
21	GI/T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.003	0.1736	0.2503	1.000	2 x 1	N/A	4.007	3.985	Double	0.2505	TT bolt	NAS 454-4
22	GI/T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	0.237	0.1785	0.2512	1.000	2 x 1	N/A	3.950	3.981	Double	0.2512	TT bolt	NAS 454-4
23	GI/T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1768	0.2501	1.000	2 x 1	N/A	4.018	3.998	Double	0.2505	TT bolt	NAS 454-4
24	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.002	0.1709	0.2503	1.000	2 x 1	N/A	4.003	3.995	Double	0.2516	TT bolt	NAS 454-4
25	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.002	0.1739	0.2516	1.000	2 x 1	N/A	3.971	3.978	Double	0.2516	TT bolt	NAS 454-4
26	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.004	0.1734	0.2506	1.000	2 x 1	N/A	4.003	3.987	Double	0.2508	TT bolt	NAS 454-4
27	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	0.988	0.1724	0.2505	1.000	2 x 1	N/A	3.984	3.992	Double	0.2505	TT bolt	NAS 454-4
28	T300/N5208	25/50/25	[0]45/50/045/5/45/50/45/50/45/50	0.997	0.185	0.2569	1.000	2 x 1	N/A	3.881	3.893	Double	0.2569	TT bolt	NAS 454-4
29	T300/N5208	25/50/25	[0]45/50/045/5/45/50/45/50/45/50	1.003	0.1631	0.2529	1.000	2 x 1	N/A	3.973	3.861	Double	0.2525	TT bolt	NAS 454-4
30	T300/N5208	25/50/25	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1724	0.2536	1.000	2 x 1	N/A	3.983	3.943	Double	0.2536	TT bolt	NAS 454-4
31	T300/N5208	25/50/25	[0]45/50/045/5/45/50/45/50/45/50	0.987	0.1805	0.2526	1.000	2 x 1	N/A	4.006	3.903	Double	0.2508	TT bolt	NAS 454-4
32	T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.003	0.1237	0.2504	1.000	2 x 1	N/A	4.006	3.994	Double	0.2504	TT bolt	NAS 454-4
33	T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.002	0.1812	0.2507	1.000	2 x 1	N/A	3.950	3.982	Double	0.2507	TT bolt	NAS 454-4
34	T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.001	0.1885	0.2525	1.000	2 x 1	N/A	4.001	3.986	Double	0.2525	TT bolt	NAS 454-4
35	T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1724	0.2512	1.000	2 x 1	N/A	3.941	3.943	Double	0.2512	TT bolt	NAS 454-4
36	T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.004	0.1848	0.2532	1.000	2 x 1	N/A	3.925	3.949	Double	0.2532	TT bolt	NAS 454-4
37	T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.020	0.1862	0.2548	1.000	2 x 1	N/A	4.013	3.925	Double	0.2548	TT bolt	NAS 454-4
38	T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1751	0.2539	1.000	2 x 1	N/A	3.975	3.939	Double	0.2539	TT bolt	NAS 454-4
39	T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.010	0.1794	0.2504	1.000	2 x 1	N/A	4.000	3.964	Double	0.2504	TT bolt	NAS 454-4
40	GI/T300/N5208	25/150/25	[0]45/50/045/5/45/50/45/50/45/50	0.980	0.1929	0.2512	1.000	2 x 1	N/A	3.950	3.941	Double	0.2512	TT bolt	NAS 454-4
41	GI/T300/N5208	25/150/25	[0]45/50/045/5/45/50/45/50/45/50	0.987	0.1805	0.2526	1.000	2 x 1	N/A	4.006	3.965	Double	0.2532	TT bolt	NAS 454-4
42	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.004	0.1804	0.2524	1.000	2 x 1	N/A	3.978	3.962	Double	0.2524	TT bolt	NAS 454-4
43	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	0.999	0.1813	0.2513	1.000	2 x 1	N/A	4.000	3.979	Double	0.2513	TT bolt	NAS 454-4
44	GI/T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1751	0.2524	1.000	2 x 1	N/A	4.000	4.164	Double	0.2504	TT bolt	NAS 454-4
45	GI/T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	0.985	0.1734	0.2538	1.000	2 x 1	N/A	3.950	3.947	Double	0.2519	TT bolt	NAS 454-4
46	GI/T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1796	0.2520	1.000	2 x 1	N/A	4.017	3.997	Double	0.2523	TT bolt	NAS 454-4
47	GI/T300/N5208	37.5/37.5/25	[0]45/50/045/5/45/50/45/50/45/50	0.999	0.1745	0.2522	1.000	2 x 1	N/A	3.950	3.924	Double	0.2522	TT bolt	NAS 454-4
48	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.003	0.1803	0.2527	1.000	2 x 1	N/A	4.000	3.988	Double	0.2505	TT bolt	NAS 454-4
49	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	1.005	0.1744	0.2501	1.000	2 x 1	N/A	4.018	3.998	Double	0.2501	TT bolt	NAS 454-4
50	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	0.985	0.1729	0.2535	1.000	2 x 1	N/A	4.000	3.972	Double	0.2505	TT bolt	NAS 454-4
51	GI/T300/N5208	37.5/50/12.5	[0]45/50/045/5/45/50/45/50/45/50	0.924	0.1711	0.2532	1.000	2 x 1	N/A	4.000	3.924	Double	0.2533	TT bolt	NAS 454-4
52	AS1/3501-6	50/40/10	[0]45/50/045/5/45/50/45/50/45/50	1.001	0.2139	0.2511	0.750	2 x 1	N/A	3.950	3.980	Double	0.2489	ST3M453-6-34	Bolt, Sheet
53	AS1/3501-6	50/40/10	[0]45/50/045/5/45/50/45/50/45/50	1.001	0.2133	0.2500	0.750	2 x 1	N/A	4.004	3.903	Double	0.2498	ST3M453-6-34	Bolt, Sheet
54	AS1/3501-6	50/40/10	[0]45/50/045/5/45/50/45/50/45/50	1.001	0.2133	0.249	0.750	2 x 1	N/A	4.000	3.928	Double	0.2498	ST3M453-6-34	Bolt, Sheet
55	AS1/3501-6	50/40/10	[0]45/50/045/5/45/50/45/50/45/50	1.001	0.2133	0.249	0.750	2 x 1	N/A	4.000	3.928	Double	0.2498	ST3M453-6-34	Bolt, Sheet

P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
1	Fastener Type	Test	Molten	Bearing Stress	Gross	Shearout	Gross	Removal Mode			Reference	Remarks	AD Proportions	
2	Torque of	Load	Content	Falling	Initial	Non-	Strength	Initial	Non-					
3	In-lb	(lb.)	(% by Wh)		(lb.)	(lb.)	(lb.)	(lb.)	(lb.)					
4	25 Tension	RT	Unknown	5040	Unknown	55.0	Unknown	28.1	5.6	Unknown	Hart-Smith [1-17]	Ti Bolt ten. strength=160 ksi		
5	25 Tension	RT	Unknown	5180	Unknown	58.8	Unknown	29.1	5.8	Unknown	Hart-Smith [1-17]			
6	25 Tension	RT	Unknown	5180	Unknown	66.2	Unknown	28.4	5.7	Unknown	Hart-Smith [1-17]			
7	25 Tension	RT	Unknown	5180	Unknown	55.2	Unknown	29.3	5.7	Unknown	Hart-Smith [1-17]			
8	25 Tension	RT	Unknown	6020	Unknown	66.1	Unknown	32.8	6.6	Unknown	Hart-Smith [1-17]	Ti Bolt ten. strength=160 ksi		
9	25 Tension	RT	Unknown	6420	Unknown	68.2	Unknown	34.2	6.9	Unknown	Hart-Smith [1-17]			
10	25 Tension	RT	Unknown	6220	Unknown	68.1	Unknown	34.5	6.9	Unknown	Hart-Smith [1-17]			
11	25 Tension	RT	Unknown	5750	Unknown	62.5	Unknown	31.3	6.3	Unknown	Hart-Smith [1-17]			
12	25 Tension	RT	Unknown	8300	Unknown	74.5	Unknown	37.5	7.5	Unknown	Hart-Smith [1-17]	Ti Bolt ten. strength=160 ksi		
13	25 Tension	RT	Unknown	6180	Unknown	72.0	Unknown	36.2	7.2	Unknown	Hart-Smith [1-17]			
14	25 Tension	RT	Unknown	8280	Unknown	73.4	Unknown	36.8	7.4	Unknown	Hart-Smith [1-17]			
15	25 Tension	RT	Unknown	5940	Unknown	62.1	Unknown	31.6	6.4	Unknown	Hart-Smith [1-17]			
16	25 Tension	RT	Unknown	6670	Unknown	74.2	Unknown	37.5	7.5	Unknown	Hart-Smith [1-17]			
17	25 Tension	RT	Unknown	7170	Unknown	79.5	Unknown	40.3	8.1	Unknown	Hart-Smith [1-17]			
18	25 Tension	RT	Unknown	6840	Unknown	77.0	Unknown	38.3	7.7	Unknown	Hart-Smith [1-17]			
19	25 Tension	RT	Unknown	7040	Unknown	79.1	Unknown	39.8	8.0	Unknown	Hart-Smith [1-17]			
20	25 Tension	RT	Unknown	8040	Unknown	91.2	Unknown	45.6	9.2	Unknown	Hart-Smith [1-17]			
21	25 Tension	RT	Unknown	7530	Unknown	86.5	Unknown	43.2	8.7	Unknown	Hart-Smith [1-17]			
22	25 Tension	RT	Unknown	8780	Unknown	87.8	Unknown	44.2	8.9	Unknown	Hart-Smith [1-17]			
23	25 Tension	RT	Unknown	7860	Unknown	86.9	Unknown	44.2	8.9	Unknown	Hart-Smith [1-17]			
24	25 Tension	RT	Unknown	7780	Unknown	90.9	Unknown	45.4	9.1	Unknown	Hart-Smith [1-17]			
25	25 Tension	RT	Unknown	7900	Unknown	90.5	Unknown	45.5	9.1	Unknown	Hart-Smith [1-17]			
26	25 Tension	RT	Unknown	7830	Unknown	91.2	Unknown	45.6	9.1	Unknown	Hart-Smith [1-17]			
27	25 Tension	RT	Unknown	8020	Unknown	82.9	Unknown	46.6	9.2	Unknown	Hart-Smith [1-17]			
28	25 Comp.	RT	Unknown	-8150	Unknown	-85.7	Unknown	-44.2	-8.8	Unknown	Hart-Smith [1-17]			
29	25 Comp.	RT	Unknown	-8825	Unknown	-93.0	Unknown	-48.1	-9.6	Unknown	Hart-Smith [1-17]			
30	25 Comp.	RT	Unknown	-9180	Unknown	-105.1	Unknown	-53.0	-10.7	Unknown	Hart-Smith [1-17]			
31	25 Comp.	RT	Unknown	-8320	Unknown	-90.0	Unknown	-46.2	-9.2	Unknown	Hart-Smith [1-17]			
32	25 Comp.	RT	Unknown	-9265	Unknown	-101.0	Unknown	-50.4	-10.1	Unknown	Hart-Smith [1-17]			
33	25 Comp.	RT	Unknown	-9400	Unknown	-103.5	Unknown	-51.8	-10.4	Unknown	Hart-Smith [1-17]			
34	25 Comp.	RT	Unknown	-9980	Unknown	-106.8	Unknown	-63.9	-10.8	Unknown	Hart-Smith [1-17]			
35	25 Comp.	RT	Unknown	-9180	Unknown	-99.9	Unknown	-50.7	-10.0	Unknown	Hart-Smith [1-17]			
36	25 Comp.	RT	Unknown	-7290	Unknown	-81.1	Unknown	-40.7	-9.2	Unknown	Hart-Smith [1-17]			
37	25 Comp.	RT	Unknown	-7680	Unknown	-83.5	Unknown	-41.7	-9.5	Unknown	Hart-Smith [1-17]			
38	25 Comp.	RT	Unknown	-8320	Unknown	-93.6	Unknown	-47.5	-9.6	Unknown	Hart-Smith [1-17]			
39	25 Comp.	RT	Unknown	-7120	Unknown	-79.2	Unknown	-39.3	-7.9	Unknown	Hart-Smith [1-17]			
40	25 Comp.	RT	Unknown	-7086	Unknown	-78.4	Unknown	-39.3	-7.9	Unknown	Hart-Smith [1-17]			
41	25 Comp.	RT	Unknown	-7310	Unknown	-81.1	Unknown	-40.7	-9.2	Unknown	Hart-Smith [1-17]			
42	25 Comp.	RT	Unknown	-7830	Unknown	-86.0	Unknown	-43.2	-8.7	Unknown	Hart-Smith [1-17]			
43	25 Comp.	RT	Unknown	-7695	Unknown	-89.0	Unknown	-40.7	-8.1	Unknown	Hart-Smith [1-17]			
44	25 Comp.	RT	Unknown	-6880	Unknown	-74.3	Unknown	-36.8	-7.6	Unknown	Hart-Smith [1-17]			
45	25 Comp.	RT	Unknown	-6890	Unknown	-78.3	Unknown	-39.3	-7.9	Unknown	Hart-Smith [1-17]			
46	25 Comp.	RT	Unknown	-8860	Unknown	-97.4	Unknown	-40.6	-9.2	Unknown	Hart-Smith [1-17]			
47	25 Comp.	RT	Unknown	-7630	Unknown	-86.7	Unknown	-43.8	-8.7	Unknown	Hart-Smith [1-17]			
48	25 Comp.	RT	Unknown	-7370	Unknown	-80.9	Unknown	-44.6	-8.9	Unknown	Hart-Smith [1-17]			
49	25 Comp.	RT	Unknown	-6590	Unknown	-94.7	Unknown	-47.7	-9.5	Unknown	Hart-Smith [1-17]			
50	25 Comp.	RT	Unknown	-8200	Unknown	-90.4	Unknown	-46.1	-9.2	Unknown	Hart-Smith [1-17]			
51	25 Comp.	RT	Unknown	-7840	Unknown	-97.4	Unknown	-40.6	-9.2	Unknown	Hart-Smith [1-17]			
52	0 Tension	RT	0.00	10780	Unknown	100.7	Unknown	-	-					
53	0 Tension	RT	0.00	12600	Unknown	117.2	Unknown	-	-					
54	0 Tension	RT	0.00	13160	Unknown	123.9	Unknown	4.1	17.8	3870	Br. Sh.	Carbo et al. [1-38]		
55	0 Tension	RT	0.00	13140	Unknown	123.7	Unknown	4.10	17.8	40000	Br. Sh.	Carbo et al. [1-38]		



P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	
56	25	Tension	RT	0.00	1395	Unknown	114.7	Unknown	38.3	16.5	3635	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
57	25	Tension	RT	0.00	13980	Unknown	114.6	Unknown	38.2	16.4	3125	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
58	25	Tension	RT	0.00	15300	Unknown	131.6	Unknown	43.7	16.8	4290	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
59	25	Tension	RT	0.00	14380	Unknown	124.1	Unknown	41.1	17.7	4080	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
60	0	Tension	RT	0.77	9230	Unknown	96.0	Unknown	32.3	13.9	2715	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
61	0	Tension	RT	0.72	8970	Unknown	92.5	Unknown	30.9	13.3	2670	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
62	0	Tension	RT	0.80	8400	Unknown	82.3	Unknown	27.8	11.9	2650	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
63	0	Tension	RT	0.97	10400	Unknown	88.6	Unknown	30.1	13.0	2970	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
64	50	Tension	RT	0.00	10100	Unknown	103.2	Unknown	34.1	14.7	2840	Br.	Sh	Steel bolt, G/E specimen	
65	50	Tension	RT	0.00	11850	Unknown	118.0	Unknown	39.3	16.9	3665	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
66	50	Tension	RT	0.00	11840	Unknown	118.9	Unknown	39.3	16.9	3290	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
67	50	Tension	RT	0.00	13170	Unknown	134.0	Unknown	44.5	19.1	3655	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
68	50	Tension	RT	0.75	12360	Unknown	122.6	Unknown	41.4	17.8	3770	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
69	50	Tension	RT	0.74	11050	Unknown	111.7	Unknown	37.5	16.1	3285	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
70	50	Tension	RT	0.84	121.0	Unknown	121.0	Unknown	40.5	17.4	3880	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
71	50	Tension	RT	0.86	13030	Unknown	122.6	Unknown	40.8	17.5	3805	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
72	50	Tension	RT	0.91	10240	Unknown	93.0	Unknown	31.3	13.4	2650	Bear.		Gardo et. al [1-38] Steel bolt, G/E specimen	
73	50	Tension	RT	0.98	10780	Unknown	102.6	Unknown	34.3	14.7	3225	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen	
74	50	Tension	RT	250	0.88	10820	Unknown	104.5	Unknown	36.4	16.2	3267	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen
75	50	Tension	RT	250	0.81	9740	Unknown	91.7	Unknown	30.9	13.3	2840	Br.	Sh	Gardo et. al [1-38] Steel bolt, G/E specimen
76	50	Tension	RT	0.00	22500	Unknown	112.6	Unknown	37.7	16.2	3215	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
77	50	Tension	RT	0.00	22700	Unknown	114.3	Unknown	38.0	16.3	3290	Bear.		Gardo et. al [1-38] Bushing bet. bolt & specimen	
78	50	Tension	RT	0.00	17800	Unknown	91.4	Unknown	30.5	13.1	2815	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
79	50	Tension	RT	0.00	22800	Unknown	117.8	Unknown	39.2	16.8	3320	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
80	50	Tension	RT	0.00	18000	Unknown	111.4	Unknown	37.0	15.9	3220	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
81	50	Tension	RT	0.00	18800	Unknown	118.9	Unknown	38.8	16.7	3385	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
82	180	Tension	RT	0.00	19750	Unknown	123.1	Unknown	41.0	17.6	3485	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
83	180	Tension	RT	0.00	20925	Unknown	130.4	Unknown	43.4	18.6	3260	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
84	50	Tension	RT	0.00	8500	Unknown	117.3	Unknown	38.8	16.8	3140	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
85	50	Tension	RT	0.00	9480	Unknown	118.2	Unknown	38.8	16.6	3105	Bear.		Gardo et. al [1-38] Bushing bet. bolt & specimen	
86	50	Tension	RT	0.00	9520	Unknown	117.5	Unknown	38.9	16.7	3185	Bear.		Gardo et. al [1-38] Early bolt failure in shear!	
87	50	Tension	RT	0.00	10220	Unknown	104.8	Unknown	34.8	17.4	3045	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
88	50	Tension	RT	0.00	10800	Unknown	110.9	Unknown	36.7	18.4	3205	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
89	50	Tension	RT	0.00	11270	Unknown	115.3	Unknown	38.3	19.2	3420	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
90	60	Tension	RT	0.00	11080	Unknown	113.1	Unknown	37.6	18.9	3380	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
91	60	Tension	RT	0.00	14420	Unknown	144.4	Unknown	49.0	18.4	4365	Bear.		Gardo et. al [1-38] Bushing bet. bolt & specimen	
92	60	Tension	RT	0.00	15200	Unknown	136.4	Unknown	44.9	18.9	4115	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
93	60	Tension	RT	0.00	14000	Unknown	143.0	Unknown	47.6	17.9	4420	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
94	60	Tension	RT	0.00	13980	Unknown	138.7	Unknown	46.5	17.1	4120	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
95	60	Tension	RT	0.00	8740	Unknown	89.7	Unknown	29.7	16.3	2620	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
96	60	Tension	RT	0.00	9820	Unknown	98.8	Unknown	32.3	17.7	2870	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
97	60	Tension	RT	0.00	9390	Unknown	95.8	Unknown	31.9	17.4	2655	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
98	60	Tension	RT	0.00	12180	Unknown	113.4	Unknown	30.7	16.8	2880	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
99	60	Tension	RT	0.00	12440	Unknown	112.7	Unknown	37.6	18.9	3445	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
100	60	Tension	RT	0.00	12880	Unknown	123.2	Unknown	40.9	20.5	3150	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
101	60	Tension	RT	0.00	13800	Unknown	122.9	Unknown	40.8	20.6	3380	Ten-CIV		Gardo et. al [1-38] Bushing bet. bolt & specimen	
102	60	Tension	RT	0.00	13780	Unknown	122.9	Unknown	40.8	20.6	3680	Ten-CIV		Gardo et. al [1-38] Bushing bet. bolt & specimen	
103	50	Tension	RT	0.00	14600	Unknown	130.3	Unknown	43.3	21.7	4050	Ten-CIV		Gardo et. al [1-38] Bushing bet. bolt & specimen	
104	50	Tension	RT	0.00	12180	Unknown	113.4	Unknown	37.9	22.9	3100	Ten-CIV		Gardo et. al [1-38] Bushing bet. bolt & specimen	
105	50	Tension	RT	0.00	12440	Unknown	116.8	Unknown	38.7	23.4	3480	Ten-CIV		Gardo et. al [1-38] Bushing bet. bolt & specimen	
106	60	Tension	RT	0.00	12880	Unknown	116.9	Unknown	38.8	23.4	3385	Ten-CIV		Gardo et. al [1-38] Bushing bet. bolt & specimen	
107	60	Tension	RT	0.00	12880	Unknown	116.9	Unknown	38.4	23.2	3600	Ten-CIV		Gardo et. al [1-38] Bushing bet. bolt & specimen	
108	60	Tension	RT	0.93	11480	Unknown	98.2	Unknown	33.0	9.9	3270	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
109	50	Tension	RT	0.85	11280	Unknown	107.6	Unknown	36.1	10.8	3126	Shear		Gardo et. al [1-38] Bushing bet. bolt & specimen	
110	60	Tension	RT	0.81	8480	Unknown	82.0	Unknown	27.6	8.3	2450	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	
111	50	Tension	RT	0.79	8480	Unknown	84.9	Unknown	28.6	9.6	2620	Br.	Sh	Gardo et. al [1-38] Bushing bet. bolt & specimen	



P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
112	50	Tension	250	0.76	10480	Unknown	104.5	Unknown	35.0	10.5	3105	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
113	50	Tension	250	0.75	11040	Unknown	110.9	Unknown	37.2	11.2	3420	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
114	50	Tension	250	0.89	10200	Unknown	91.4	Unknown	31.7	9.5	3020	Fr. Sh	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
115	60	Tension	250	0.90	10020	Unknown	91.4	Unknown	30.6	9.2	2850	Fr. Sh	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
116	50	Tension	250	0.92	9120	Unknown	79.1	Unknown	26.2	7.9	2360	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
117	50	Tension	250	0.85	91010	Unknown	95.0	Unknown	28.2	8.5	2630	Fr. Sh	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
118	50	Tension	250	0.78	7370	Unknown	73.6	Unknown	24.9	7.6	2230	Fr. Sh	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
119	50	Tension	250	0.89	6980	Unknown	64.9	Unknown	21.6	6.5	2150	Fr. Sh	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
120	50	Tension	250	0.79	10330	Unknown	89.3	Unknown	33.3	11.1	3105	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
121	50	Tension	250	0.84	12630	Unknown	108.1	Unknown	36.2	12.1	3575	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
122	50	Tension	250	0.86	11700	Unknown	110.6	Unknown	36.9	12.3	3372	Fr. Sh	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
123	50	Tension	250	0.80	8480	Unknown	81.2	Unknown	27.3	9.1	2562	Fr. Sh	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
124	50	Tension	250	0.84	8330	Unknown	87.9	Unknown	29.3	11.0	2750	Fr. Sh.	Ganbo et. al. [1-38]	No bushing bet. bolt & spec.
125	60	Tension	250	0.87	8920	Unknown	84.0	Unknown	28.1	10.6	2655	Fr. Sh.	Ganbo et. al. [1-38]	No bushing bet. bolt & spec.
126	50	Tension	250	0.95	7560	Unknown	67.3	Unknown	22.6	8.5	2260	Fr. Sh.	Ganbo et. al. [1-38]	No bushing bet. bolt & spec.
127	50	Tension	250	0.97	8860	Unknown	76.7	Unknown	25.4	9.8	4300	Fr. Sh.	Ganbo et. al. [1-38]	No bushing bet. bolt & spec.
128	50	Tension	FT	0.00	11430	Unknown	107.5	Unknown	54.0	16.5	5050	Tens	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
129	50	Tension	FT	0.00	10720	Unknown	101.6	Unknown	50.8	14.6	4700	Tens	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
130	50	Tension	FT	0.00	9780	Unknown	92.8	Unknown	46.2	13.3	4500	Tens	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
131	50	Tension	FT	0.00	10160	Unknown	95.7	Unknown	47.7	13.7	4700	Tens	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
132	50	Tension	FT	0.00	12860	Unknown	118.6	Unknown	47.3	16.9	4340	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
133	50	Tension	FT	0.00	12880	Unknown	119.4	Unknown	47.6	17.1	4515	Tens	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
134	50	Tension	FT	0.00	12860	Unknown	116.8	Unknown	46.6	16.7	4415	Tens	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
135	50	Tension	FT	0.00	12760	Unknown	116.8	Unknown	47.2	16.9	4540	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
136	50	Tension	FT	0.00	13200	Unknown	123.9	Unknown	31.2	17.8	2875	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
137	50	Tension	FT	0.00	13040	Unknown	123.4	Unknown	30.8	17.8	3085	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
138	50	Tension	FT	0.00	13700	Unknown	129.6	Unknown	32.3	18.6	3015	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
139	50	Tension	FT	0.00	13300	Unknown	80.8	Unknown	41.9	18.0	3880	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
140	50	Tension	FT	0.73	10440	Unknown	96.3	Unknown	24.4	8.1	2940	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
141	50	Tension	FT	0.86	10820	Unknown	99.0	Unknown	25.0	8.4	2400	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
142	60	Tension	FT	0.00	13200	Unknown	73.9	Unknown	19.5	8.2	1890	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
143	50	Tension	FT	0.86	11660	Unknown	107.2	Unknown	26.9	9.0	2680	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
144	60	Tension	FT	0.72	10230	Unknown	104.5	Unknown	41.9	11.7	3860	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
145	50	Tension	FT	0.82	11640	Unknown	111.5	Unknown	44.8	12.5	4200	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
146	50	Tension	FT	0.75	10120	Unknown	101.7	Unknown	41.0	11.4	3600	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
147	60	Tension	FT	0.86	10160	Unknown	97.8	Unknown	39.9	10.8	3820	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
148	50	Tension	FT	0.75	9820	Unknown	99.4	Unknown	49.7	12.4	4216	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
149	60	Tension	FT	0.86	11660	Unknown	110.2	Unknown	56.3	13.9	4700	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
150	50	Tension	FT	0.80	11040	Unknown	91.6	Unknown	46.1	11.6	3890	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
151	50	Tension	FT	0.74	8840	Unknown	132.4	Unknown	47.1	11.8	4330	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
152	50	Tension	FT	0.82	9480	Unknown	94.8	Unknown	41.1	11.4	3600	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
153	60	Tension	FT	0.90	12840	Unknown	122.9	Unknown	41.1	11.8	3800	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
154	50	Tension	FT	0.00	13600	Unknown	130.6	Unknown	42.6	16.7	4056	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
155	50	Tension	FT	0.80	13460	Unknown	129.2	Unknown	43.0	16.6	4040	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
156	50	Tension	FT	0.74	8840	Unknown	91.6	Unknown	44.1	16.9	4080	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
157	50	Tension	FT	0.81	12860	Unknown	132.4	Unknown	40.1	17.3	3715	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
158	50	Tension	FT	0.79	12800	Unknown	123.9	Unknown	41.7	17.9	3800	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
159	50	Tension	FT	0.77	12800	Unknown	122.1	Unknown	41.1	17.7	3786	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
160	50	Tension	FT	0.82	14100	Unknown	139.0	Unknown	46.3	18.7	4206	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
161	50	Tension	FT	0.86	11200	Unknown	109.7	Unknown	36.0	16.7	3330	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
162	50	Tension	FT	0.75	10700	Unknown	107.4	Unknown	40.1	17.3	3326	Bear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
163	50	Tension	FT	0.78	9000	Unknown	86.4	Unknown	41.7	17.9	2650	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
164	50	Tension	FT	0.87	9880	Unknown	93.5	Unknown	31.2	13.4	3000	Fr. Sh.	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
165	50	Tension	FT	0.80	8040	Unknown	85.4	Unknown	42.6	12.3	1830	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
166	50	Tension	FT	0.90	8370	Unknown	89.7	Unknown	29.9	12.8	2048	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
167	50	Tension	FT	0.00	8360	Unknown	89.4	Unknown	29.8	12.8	2256	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen
168	50	Tension	FT	0.00	9059	Unknown	96.8	Unknown	32.3	13.8	2176	Shear	Ganbo et. al. [1-38]	Bushing bet. bolt & specimen



P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
168	50 Tension	250	0.73	6140 Unknown	65.5 Unknown	21.9	9.4	1415 Br.	Sh	Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
169	50 Tension	250	0.71	6460 Unknown	67.0 Unknown	22.8	9.6	1460 Br.	Sh	Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
170	50 Tension	250	0.69	4820 Unknown	51.7 Unknown	17.2	7.4	1190 Br.	Sh	Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
171	50 Tension	250	0.73	5550 Unknown	58.9 Unknown	19.6	8.4	1300 Br.	Sh	Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
172	50 Tension	RT	0.00	13000 Unknown	120.9 Unknown	40.3	17.3	5310 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
173	50 Tension	Sh	0.00	13050 Unknown	121.8 Unknown	40.4	17.4	5300 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
174	50 Tension	RT	0.00	13640 Unknown	127.4 Unknown	42.3	18.2	5660 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
175	50 Tension	Sh	0.00	13380 Unknown	124.9 Unknown	41.4	17.8	5600 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
176	50 Tension	250	0.89	11880 Unknown	107.6 Unknown	36.4	15.6	6440 Bear		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
177	50 Tension	250	0.87	11480 Unknown	107.7 Unknown	36.9	15.4	4850 Bear		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
178	50 Tension	250	0.90	9800 Unknown	89.8 Unknown	30.1	12.9	4280 Bear		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
179	50 Tension	250	0.92	9680 Unknown	89.4 Unknown	29.9	12.9	4250 Bear		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
180	50 Tension	RT	0.00	24700 Unknown	117.1 Unknown	47.5	17.0	4430 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
181	50 Tension	Sh	0.00	25350 Unknown	127.1 Unknown	51.2	18.4	4120 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
182	50 Tension	RT	0.00	24900 Unknown	114.0 Unknown	45.9	16.4	4390 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
183	50 Tension	Sh	0.00	24900 Unknown	113.2 Unknown	45.6	16.3	4465 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
184	50 Tension	RT	0.87	19000 Unknown	88.9 Unknown	36.0	12.9	3240 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
185	50 Tension	250	0.73	19000 Unknown	96.8 Unknown	39.1	14.0	3480 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
186	50 Tension	250	0.78	20950 Unknown	104.8 Unknown	42.0	15.1	3570 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
187	50 Tension	250	0.74	19650 Unknown	95.3 Unknown	36.3	12.7	3220 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
188	50 Tension	Sh	0.00	26150 Unknown	126.8 Unknown	61.3	18.4	4580 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
189	50 Tension	RT	0.00	25200 Unknown	118.1 Unknown	47.7	17.0	4200 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
190	50 Tension	Sh	0.00	25200 Unknown	117.3 Unknown	47.0	16.8	4140 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
191	50 Tension	RT	0.00	26250 Unknown	128.0 Unknown	51.5	18.4	4460 Tens		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
192	50 Tension	250	0.88	23200 Unknown	108.0 Unknown	43.4	16.5	4040 Shear		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
193	50 Tension	250	0.82	21900 Unknown	106.3 Unknown	42.9	15.3	3980 Ten-clav		Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
194	50 Tension	250	0.87	20200 Unknown	94.2 Unknown	37.9	13.6	3620 Br.	Sh	Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
195	50 Tension	250	0.70	20750 Unknown	106.0 Unknown	42.7	15.2	3970 Br.	Sh	Carbo et. al. [1-36]	Bushing bei. bolt & specimen			
196	50 Tension	RT	0.00	26600 Unknown	136.4 Unknown	54.8	19.5	4500 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
197	50 Tension	Sh	0.00	26250 Unknown	130.5 Unknown	52.5	18.8	4510 Ten-clav		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
198	50 Tension	RT	0.00	27050 Unknown	139.8 Unknown	56.3	20.1	4720 Ten-clav		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
199	50 Tension	Sh	0.00	26500 Unknown	120.0 Unknown	48.3	17.3	4690 Ten-clav		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
200	50 Tension	250	0.90	24750 Unknown	113.0 Unknown	45.9	16.4	4460 Ten-clav		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
201	50 Tension	250	0.78	23550 Unknown	116.5 Unknown	47.1	16.8	4340 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
202	50 Tension	250	0.89	22700 Unknown	106.1 Unknown	42.4	15.2	4180 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
203	50 Tension	250	0.84	22700 Unknown	106.3 Unknown	42.7	16.3	4320 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
204	50 Tension	250	0.76	23000 Unknown	116.3 Unknown	46.7	16.7	4610 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
205	50 Tension	250	0.73	23150 Unknown	118.2 Unknown	47.8	17.0	4385 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
206	50 Tension	250	0.88	25500 Unknown	119.4 Unknown	48.0	17.2	5085 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
207	50 Tension	260	0.86	22900 Unknown	110.3 Unknown	44.5	16.9	4360 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
208	50 Tension	RT	0.00	22800 Unknown	106.3 Unknown	42.8	15.3	5610 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
209	50 Tension	Sh	0.00	22600 Unknown	106.7 Unknown	42.9	15.4	5630 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
210	50 Tension	RT	0.00	23550 Unknown	107.1 Unknown	43.3	15.5	5640 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
211	50 Tension	Sh	0.00	22650 Unknown	102.0 Unknown	41.0	14.7	5300 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
212	50 Tension	250	0.91	19400 Unknown	98.7 Unknown	36.2	12.6	4925 Bear		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
213	50 Tension	260	0.92	20300 Unknown	92.8 Unknown	37.4	13.3	5400 Bear		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
214	50 Tension	260	0.81	21375 Unknown	96.7 Unknown	39.3	14.0	5160 Br.	Tens	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
215	50 Tension	260	0.89	21225 Unknown	97.8 Unknown	39.4	14.1	5080 Br.	Tens-clav	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
216	50 Tension	Sh	0.00	21100 Unknown	101.8 Unknown	40.9	14.6	5310 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
217	50 Tension	RT	0.00	21600 Unknown	101.8 Unknown	41.2	14.7	3580 Br.	Sh	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
218	50 Tension	Sh	0.00	21050 Unknown	101.7 Unknown	40.8	14.6	3260 Br.	Tens-clav	Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
219	50 Tension	Sh	0.00	21300 Unknown	101.3 Unknown	41.1	14.7	4620 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
220	50 Tension	Sh	0.00	20900 Unknown	98.7 Unknown	39.6	14.2	4690 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
221	50 Tension	Sh	0.00	20700 Unknown	98.9 Unknown	39.8	14.2	4460 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
222	50 Tension	Sh	0.00	20460 Unknown	98.5 Unknown	39.8	14.3	4990 Tens		Carbo et. al. [1-36]	No bushing bei. bolt & spec.			
223	50 Tension	Sh	0.00	22600 Unknown	111.5 Unknown	45.2	16.1			Carbo et. al. [1-36]	No bushing bei. bolt & spec.			

A		B		C		D		E		F		G		H		I		J		K		L		M		O
224	A\$1/3501-6	50/40/10	145/0/-45/0/90/-0/45/0/-45/0/8	1508	0/2225	0/2517	0/750/2/1	N/A	1.000	5.991	2.980	Single	0.249	ST3M453-4-18	Bolt,	Steel										
225	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1502	0/1996	0/2521	0/750/2/1	N/A	1.000	5.958	2.975	Single	0.249	ST3M453-4-18	Bolt,	Steel										
226	A\$1/3501-6	50/40/10	145/0/-45/0/90/-0/45/0/-45/0/8	1502	0/1976	0/2505	0/750/2/1	N/A	1.000	5.994	2.994	Single	0.249	ST3M453-4-18	Bolt,	Steel										
227	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1504	0/2105	0/2518	0/750/2/1	N/A	1.000	5.981	2.979	Single	0.249	ST3M453-4-18	Bolt,	Steel										
228	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/1953	0/251	0/750/2/1	N/A	1.000	5.968	2.988	Single	0.249	ST3M453-4-18	Bolt,	Steel										
229	A\$1/3501-6	50/40/10	145/0/-45/0/90/-0/45/0/-45/0/8	1504	0/1973	0/253	0/750/2/1	N/A	1.000	5.945	2.984	Single	0.249	ST3M453-4-18	Bolt,	Steel										
230	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1501	0/1884	0/253	0/750/2/1	N/A	1.000	5.933	2.964	Single	0.249	ST3M453-4-18	Bolt,	Steel										
231	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1508	0/2122	0/253	0/750/2/1	N/A	1.000	5.980	2.984	Single	0.249	ST3M453-4-18	Bolt,	Steel										
232	A\$1/3501-6	50/40/10	145/0/-45/0/90/-0/45/0/-45/0/8	1502	0/2216	0/251	0/750/2/1	N/A	1.000	5.984	2.988	Single	0.249	ST3M453-4-18	Bolt,	Steel										
233	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1517	0/238	0/252	0/750/2/1	N/A	1.000	5.984	2.988	Single	0.249	ST3M453-4-18	Bolt,	Steel										
234	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2096	0/252	0/750/2/1	N/A	1.000	5.953	2.964	Single	0.249	ST3M453-4-18	Bolt,	Steel										
235	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1504	0/2124	0/251	0/750/2/1	N/A	1.000	5.852	2.918	Single	0.249	ST3M453-4-18	Bolt,	Steel										
236	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1504	0/236	0/257	0/750/2/1	N/A	1.000	5.976	2.988	Double	0.249	ST3M453-4-26	Bolt,	Steel										
237	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2173	0/253	0/750/2/1	N/A	1.000	5.941	2.964	Double	0.249	ST3M453-4-26	Bolt,	Steel										
238	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/1888	0/252	0/750/2/1	N/A	1.000	5.964	2.976	Double	0.249	ST3M453-4-26	Bolt,	Steel										
239	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2096	0/252	0/750/2/1	N/A	1.000	5.904	2.976	Double	0.249	ST3M453-4-26	Bolt,	Steel										
240	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1502	0/2080	0/256	0/750/2/1	N/A	1.000	5.987	2.930	Double	0.249	ST3M453-4-26	Bolt,	Steel										
241	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/2089	0/249	0/750/2/1	N/A	1.000	5.044	3.012	Double	0.249	ST3M453-4-26	Bolt,	Steel										
242	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1507	0/2289	0/252	0/750/2/1	N/A	1.000	5.980	2.976	Double	0.249	ST3M453-4-26	Bolt,	Steel										
243	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1502	0/2177	0/250	0/750/2/1	N/A	1.000	5.904	2.906	Double	0.249	ST3M453-4-26	Bolt,	Steel										
244	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1502	0/2080	0/252	0/750/2/1	N/A	1.000	5.980	2.976	Double	0.249	ST3M453-4-26	Bolt,	Steel										
245	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1506	0/2216	0/252	0/750/2/1	N/A	1.000	5.976	2.976	Double	0.249	ST3M453-4-26	Bolt,	Steel										
246	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1499	0/1850	0/251	0/750/2/1	N/A	1.000	5.972	2.982	Double	0.249	ST3M453-4-26	Bolt,	Steel										
247	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/1889	0/256	0/750/2/1	N/A	1.000	5.871	2.930	Double	0.249	ST3M453-4-26	Bolt,	Steel										
248	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1490	0/1801	0/250	0/750/2/1	N/A	1.000	5.986	2.977	Double	0.249	ST3M453-4-26	Bolt,	Steel										
249	A\$1/3501-6	50/40/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/1889	0/254	0/750/2/1	N/A	1.000	5.909	2.993	Double	0.249	ST3M453-4-26	Bolt,	Steel										
250	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1499	0/1850	0/251	0/750/2/1	N/A	1.000	5.995	2.986	Double	0.249	ST3M453-4-26	Bolt,	Steel										
251	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/1889	0/256	0/750/2/1	N/A	1.000	5.956	2.978	Double	0.249	ST3M453-4-26	Bolt,	Steel										
252	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1490	0/1801	0/250	0/750/2/1	N/A	1.000	5.975	2.977	Double	0.249	ST3M453-4-26	Bolt,	Steel										
253	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/1918	0/251	0/750/2/1	N/A	1.000	5.995	2.992	Double	0.249	ST3M453-4-26	Bolt,	Steel										
254	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1497	0/1908	0/252	0/750/2/1	N/A	1.000	5.905	2.996	Double	0.249	ST3M453-4-26	Bolt,	Steel										
255	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1501	0/1905	0/252	0/750/2/1	N/A	1.000	5.978	2.956	Double	0.249	ST3M453-4-26	Bolt,	Steel										
256	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2154	0/251	0/750/2/1	N/A	1.000	5.985	2.980	Double	0.249	ST3M453-4-26	Bolt,	Steel										
257	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1504	0/2151	0/250	0/750/2/1	N/A	1.000	5.942	2.981	Double	0.249	ST3M453-4-26	Bolt,	Steel										
258	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/1918	0/251	0/750/2/1	N/A	1.000	5.985	2.984	Double	0.249	ST3M453-4-26	Bolt,	Steel										
259	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2127	0/253	0/750/2/1	N/A	1.000	5.917	2.985	Double	0.249	ST3M453-4-26	Bolt,	Steel										
260	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1504	0/2183	0/253	0/750/2/1	N/A	1.000	5.960	2.984	Double	0.249	ST3M453-4-26	Bolt,	Steel										
261	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1501	0/2146	0/250	0/750/2/1	N/A	1.000	5.985	2.972	Double	0.249	ST3M453-4-26	Bolt,	Steel										
262	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2094	0/251	0/750/2/1	N/A	1.000	5.968	2.980	Double	0.249	ST3M453-4-26	Bolt,	Steel										
263	A\$1/3501-6	70/20/10	145/0/-45/0/90/0/45/0/-45/0/8	1504	0/2118	0/252	0/750/2/1	N/A	1.000	5.979	2.977	Double	0.249	ST3M453-4-26	Bolt,	Steel										
264	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/1959	0/254	0/750/2/1	N/A	1.000	5.939	2.948	Double	0.249	ST3M453-4-23	Bolt,	Steel										
265	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1506	0/2054	0/253	0/750/2/1	N/A	1.000	5.975	2.954	Double	0.249	ST3M453-4-23	Bolt,	Steel										
266	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2081	0/252	0/750/2/1	N/A	1.000	5.925	2.975	Double	0.249	ST3M453-4-23	Bolt,	Steel										
267	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1502	0/2037	0/252	0/750/2/1	N/A	1.000	5.968	2.968	Double	0.249	ST3M453-4-23	Bolt,	Steel										
268	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2048	0/252	0/750/2/1	N/A	1.000	5.931	2.971	Double	0.249	ST3M453-4-23	Bolt,	Steel										
269	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1504	0/2054	0/254	0/750/2/1	N/A	1.000	5.959	2.968	Double	0.249	ST3M453-4-23	Bolt,	Steel										
270	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/2083	0/252	0/750/2/1	N/A	1.000	5.944	2.981	Double	0.249	ST3M453-4-23	Bolt,	Steel										
271	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1506	0/2056	0/255	0/750/2/1	N/A	1.000	5.964	2.982	Double	0.249	ST3M453-4-23	Bolt,	Steel										
272	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1503	0/2088	0/252	0/750/2/1	N/A	1.000	5.975	2.970	Double	0.249	ST3M453-4-23	Bolt,	Steel										
273	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1505	0/2091	0/252	0/750/2/1	N/A	1.000	5.974	2.974	Double	0.249	ST3M453-4-23	Bolt,	Steel										
274	A\$1/3501-6	30/60/10	145/0/-45/0/90/0/45/0/-45/0/8	1506	0/2054	0/253	0/750/2/1	N/A	1.000	5.995	2.979															

P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
224	50	Camp	RT	0.00	11350	Unknown	101.3	Unknown	33.8	14.6	2980	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
225	50	Camp	RT	0.00	11500	Unknown	114.3	Unknown	38.4	16.5	3455	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
226	50	Camp	RT	0.00	12150	Unknown	122.7	Unknown	40.9	17.6	3975	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
227	50	Camp	RT	0.00	12800	Unknown	120.7	Unknown	40.4	17.4	3710	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
228	50	Camp	RT	0.74	11500	Unknown	117.3	Unknown	39.1	16.8	3205	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
229	60	Camp	RT	0.74	10800	Unknown	106.2	Unknown	26.7	15.4	3135	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
230	50	Camp	RT	0.77	12700	Unknown	127.7	Unknown	43.0	18.6	3505	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
231	50	Camp	RT	0.82	11800	Unknown	109.9	Unknown	36.9	15.9	3190	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
232	50	Camp	RT	0.85	11700	Unknown	105.7	Unknown	35.3	16.2	3200	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
233	50	Camp	RT	0.84	10500	Unknown	97.4	Unknown	32.4	14.0	2825	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
234	50	Camp	RT	0.87	10200	Unknown	94.9	Unknown	31.9	13.7	2805	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
235	50	Camp	RT	0.88	10400	Unknown	94.7	Unknown	32.4	13.9	2820	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
236	50	Camp	RT	0.00	14100	Unknown	138.7	Unknown	48.4	19.9	4860	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
237	50	Camp	RT	0.00	13800	Unknown	125.5	Unknown	42.3	18.1	4445	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
238	50	Camp	RT	0.00	14600	Unknown	154.3	Unknown	51.7	22.2	4780	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
239	50	Camp	RT	0.00	14080	Unknown	133.3	Unknown	44.7	19.2	5280	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
240	50	Camp	RT	0.89	14000	Unknown	126.5	Unknown	43.1	18.6	4440	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
241	50	Camp	RT	0.86	14800	Unknown	143.6	Unknown	47.5	20.4	4840	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
242	50	Camp	RT	0.85	16140	Unknown	139.3	Unknown	48.8	20.1	5025	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
243	60	Camp	RT	0.82	14300	Unknown	137.7	Unknown	45.8	19.7	4860	Br. Ten-Clev	Garbo et. al. [1-38]	Bushing, bolt & specimen
244	60	Camp	RT	0.91	10800	Unknown	108.7	Unknown	35.8	15.4	3760	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
245	60	Camp	RT	0.91	11200	Unknown	100.3	Unknown	33.6	14.4	3500	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
246	50	Camp	RT	0.89	11720	Unknown	110.0	Unknown	36.7	15.7	4332	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
247	50	Camp	RT	0.90	11620	Unknown	111.2	Unknown	39.9	15.9	3568	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
248	50	Camp	RT	0.90	11440	Unknown	122.1	Unknown	41.2	17.7	3090	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
249	50	Camp	RT	0.00	10980	Unknown	117.9	Unknown	39.5	16.9	2800	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
250	50	Camp	RT	0.00	11880	Unknown	122.9	Unknown	41.9	18.0	2810	Br. Sh. bolt hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
251	50	Camp	RT	0.00	11700	Unknown	123.1	Unknown	41.1	17.6	3000	Br. Sh. bolt hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
252	50	Camp	RT	0.73	7560	Unknown	79.0	Unknown	29.7	11.5	2240	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
253	50	Camp	RT	0.75	7980	Unknown	82.7	Unknown	27.6	11.9	2185	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
254	50	Camp	RT	0.75	7500	Unknown	78.0	Unknown	29.3	11.2	2104	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
255	50	Camp	RT	0.74	7820	Unknown	81.4	Unknown	27.3	11.7	2016	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
256	50	Camp	RT	0.00	13410	Unknown	123.6	Unknown	41.4	17.8	4850	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
257	50	Camp	RT	0.00	12800	Unknown	118.7	Unknown	39.6	17.0	5620	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
258	50	Camp	RT	0.00	13380	Unknown	121.9	Unknown	40.8	17.5	6375	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
259	50	Camp	RT	0.00	13000	Unknown	122.1	Unknown	40.7	17.5	6375	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
260	50	Camp	RT	0.93	11000	Unknown	99.3	Unknown	33.6	14.4	4185	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
261	50	Camp	RT	0.92	10700	Unknown	99.4	Unknown	33.2	14.2	4420	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
262	50	Camp	RT	0.92	10000	Unknown	92.0	Unknown	31.0	13.3	5600	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
263	60	Camp	RT	0.9	9440	Unknown	87.3	Unknown	29.2	12.6	5080	Com. outside hole	Garbo et. al. [1-38]	Bushing, bolt & specimen
264	0	Camp	RT	0.00	17200	Unknown	105.8	Unknown	34.5	12.4	3305	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
265	0	Camp	RT	0.00	17500	Unknown	83.1	Unknown	33.4	11.9	3400	Bear	Garbo et. al. [1-38]	Bushing, bolt & specimen
266	0	Camp	RT	0.00	22850	Unknown	139.2	Unknown	42.5	15.2	3225	Br. Ten-Clev	Garbo et. al. [1-38]	No bushing, bolt & spec.
267	70	Camp	RT	0.00	33250	Unknown	157.7	Unknown	63.3	22.7	4160	Bear	Garbo et. al. [1-38]	Early, both failure in shear!!
268	0	Camp	RT	0.00	21380	Unknown	100.4	Unknown	40.3	14.4	6685	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
269	0	Camp	RT	0.00	23000	Unknown	105.7	Unknown	43.0	15.4	6025	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
270	70	Camp	RT	0.00	29000	Unknown	140.5	Unknown	58.9	20.4	3600	Com. outside hole	Garbo et. al. [1-38]	Early, both failure in shear!!
271	70	Camp	RT	0.00	29850	Unknown	139.2	Unknown	66.1	20.1	3620	Com. outside hole	Garbo et. al. [1-38]	Early, both failure in shear!!
272	0	Camp	RT	0.00	16800	Unknown	76.8	Unknown	31.0	11.1	2820	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
273	0	Camp	RT	0.00	23160	Unknown	111.8	Unknown	46.2	16.1	4160	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
274	70	Camp	RT	0.00	31400	Unknown	149.0	Unknown	68.9	21.5	4320	Com. outside hole	Garbo et. al. [1-38]	Early, both failure in shear!!
275	70	Camp	RT	0.00	28700	Unknown	136.9	Unknown	68.1	19.7	4320	Com. outside hole	Garbo et. al. [1-38]	No bushing, bolt & spec.
276	70	Camp	RT	0.00	16060	Unknown	77.7	Unknown	31.2	11.2	3720	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
277	0	Camp	RT	0.00	16860	Unknown	78.9	Unknown	31.8	11.4	4125	Bear	Garbo et. al. [1-38]	No bushing, bolt & spec.
278	70	Camp	RT	0.00	28200	Unknown	137.7	Unknown	66.1	19.8	3600	Com. outside hole	Garbo et. al. [1-38]	Early, both failure in shear!!
279	0	Camp	RT	0.00	23480	Unknown	113.4	Unknown	45.8	16.3	4125	Br. Co. outside hole	Garbo et. al. [1-38]	Early, both failure in shear!!



P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
286	50	Tens	RT	0.00	14100	Unknown	125.2	Unknown	41.8	18.0	4030	Ten-clev	Gardo et. al [1-38]	"Out-of-round test, with bushing
287	50	Tens	RT	0.00	13800	Unknown	122.5	Unknown	41.2	17.8	4080	Ten-clev	Gardo et. al [1-38]	"Out-of-round test, with bushing
288	50	Tens	RT	0.00	14100	Unknown	124.7	Unknown	41.8	18.0	4015	Ten-clev	Gardo et. al [1-38]	"Out-of-round test, with bushing
289	0	Tens	RT	0.00	13875	Unknown	122.3	Unknown	41.1	17.7	3930	Ten	Gardo et. al [1-38]	"Out-of-round test, with bushing
290	50	Tens	RT	0.00	14200	Unknown	135.9	Unknown	45.6	19.6	5810	Ten	Gardo et. al [1-38]	"Out-of-round test, with bushing
291	50	Tens	RT	0.00	12850	Unknown	123.4	Unknown	41.3	17.8	5210	Ten	Gardo et. al [1-38]	"Out-of-round test, with bushing
292	50	Tens	RT	0.00	12300	Unknown	117.7	Unknown	39.5	17.0	4870	Ten	Gardo et. al [1-38]	"Out-of-round test, with bushing
293	50	Tens	RT	0.00	13600	Unknown	123.9	Unknown	41.8	18.0	5120	Ten	Gardo et. al [1-38]	"Out-of-round test, with bushing
294	50	Tens	RT	0.00	13710	Unknown	121.6	Unknown	40.9	17.6	3875	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
295	50	Tens	RT	0.00	13620	Unknown	124.5	Unknown	41.3	17.8	4046	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
296	50	Tens	RT	0.00	12300	Unknown	110.8	Unknown	36.7	15.8	3615	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
297	50	Tens	RT	0.00	12750	Unknown	114.9	Unknown	38.1	16.4	3640	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
298	50	Tens	RT	0.00	13800	Unknown	129.5	Unknown	41.1	17.7	3975	Br, Ten-clev	Gardo et. al [1-38]	"Severe delam. test, with bushing
299	50	Tens	RT	0.00	13060	Unknown	117.8	Unknown	38.9	16.8	3865	Br, Ten-clev	Gardo et. al [1-38]	"Severe delam. test, with bushing
300	50	Tens	RT	0.00	11100	Unknown	99.7	Unknown	33.1	14.2	3158	Br, Ten-clev, Sh	Gardo et. al [1-38]	"Severe delam. test, with bushing
301	50	Tens	RT	0.00	11825	Unknown	105.8	Unknown	36.3	15.2	3460	Br, Sh	Gardo et. al [1-38]	"Severe delam. test, with bushing
302	50	Tens	RT	0.00	19220	Unknown	119.5	Unknown	40.1	17.3	3875	Br, Sh	Gardo et. al [1-38]	"Severe porosity, with bushing
303	50	Tens	RT	0.00	13610	Unknown	128.3	Unknown	42.9	18.5	4080	Br, Sh	Gardo et. al [1-38]	"Severe porosity, with bushing
304	50	Tens	RT	0.00	13220	Unknown	115.0	Unknown	38.7	18.7	3886	Br, Sh	Gardo et. al [1-38]	"Severe porosity, with bushing
305	50	Tens	RT	0.00	13440	Unknown	123.7	Unknown	41.4	17.8	3920	Br, Sh	Gardo et. al [1-38]	"Severe porosity, with bushing
306	50	Tens	RT	0.00	11540	Unknown	118.5	Unknown	35.5	15.3	3830	Br, Sh	Gardo et. al [1-38]	"Cak seating 80% of spe. thk; Bu.
307	50	Tens	RT	0.00	11040	Unknown	102.5	Unknown	34.0	14.6	3225	Sh, Br	Gardo et. al [1-38]	"Cak seating 80% of spe. thk; Bu.
308	50	Tens	RT	0.00	10840	Unknown	101.3	Unknown	33.8	14.5	3276	Sh, Br	Gardo et. al [1-38]	"Cak seating 80% of spe. thk; Bu.
309	50	Tens	RT	0.00	11275	Unknown	104.4	Unknown	34.7	14.9	3120	Sh, Br	Gardo et. al [1-38]	"Cak seating 80% of spe. thk; Bu.
310	50	Tens	RT	0.00	7830	Unknown	66.5	Unknown	23.2	10.0	2395	Sh, Br	Gardo et. al [1-38]	"Cak seating 100% of sp. thk; Bu.
311	50	Tens	RT	0.00	9230	Unknown	79.8	Unknown	26.5	11.4	2720	Sh, Br	Gardo et. al [1-38]	"Cak seating 100% of sp. thk; Bu.
312	50	Tens	RT	0.00	8980	Unknown	80.2	Unknown	26.7	11.5	2576	Sh, Br	Gardo et. al [1-38]	"Cak seating 100% of sp. thk; Bu.
313	50	Tens	RT	0.00	9300	Unknown	82.0	Unknown	27.6	11.9	2670	Sh, Br	Gardo et. al [1-38]	"Cak seating 100% of sp. thk; Bu.
314	50	Tens	RT	0.00	13430	Unknown	120.0	Unknown	39.8	17.2	3890	Br, Sh	Gardo et. al [1-38]	"Tiled cak away bear. surface; Bu.
315	50	Tens	RT	0.00	13950	Unknown	124.9	Unknown	41.1	17.8	4210	Sh, Br	Gardo et. al [1-38]	"Tiled cak away bear. surface; Bu.
316	50	Tens	RT	0.00	13400	Unknown	120.2	Unknown	39.7	17.2	3880	Br, Sh	Gardo et. al [1-38]	"Tiled cak away bear. surface; Bu.
317	50	Tens	RT	0.00	13800	Unknown	122.0	Unknown	40.3	17.4	3860	Br, Ten-clev	Gardo et. al [1-38]	"Tiled cak away bear. surface; Bu.
318	50	Tens	RT	0.00	10340	Unknown	93.7	Unknown	31.1	13.4	2716	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
319	50	Tens	RT	0.00	11320	Unknown	103.0	Unknown	34.1	14.7	3090	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
320	50	Tens	RT	0.00	11380	Unknown	103.5	Unknown	34.3	14.8	3080	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
321	50	Tens	RT	0.00	10875	Unknown	98.9	Unknown	32.8	14.1	3260	Br, Sh	Gardo et. al [1-38]	"Moderate delam. test, with bush.
322	50	Tens	RT	0.00	13710	Unknown	125.8	Unknown	41.4	17.8	3845	Br, Sh	Gardo et. al [1-38]	"Inference fl, with bushing
323	50	Tens	RT	0.00	14140	Unknown	129.0	Unknown	42.7	18.4	4095	Br, Sh	Gardo et. al [1-38]	"Inference fl, with bushing
324	50	Tens	RT	0.00	13800	Unknown	124.1	Unknown	41.0	17.7	3966	Br, Sh	Gardo et. al [1-38]	"Inference fl, no bushing
325	50	Tens	RT	0.00	13920	Unknown	123.0	Unknown	40.2	17.3	4036	Br, Sh	Gardo et. al [1-38]	"Inference fl, no bushing
326	50	Tens	RT	0.00	13980	Unknown	124.9	Unknown	42.2	18.1	4050	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, with bushing
327	50	Tens	RT	0.00	13700	Unknown	126.8	Unknown	41.0	17.8	3980	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, with bushing
328	50	Tens	RT	0.00	13700	Unknown	126.3	Unknown	41.4	17.8	4130	Br, Sh	Gardo et. al [1-38]	"Inference fl, no bushing
329	50	Tens	RT	0.00	12950	Unknown	121.4	Unknown	39.1	16.8	4016	Br, Sh	Gardo et. al [1-38]	"Inference fl, no bushing
330	50	Tens	RT	0.00	13160	Unknown	119.5	Unknown	36.5	15.3	3670	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
331	50	Tens	RT	0.00	13160	Unknown	120.9	Unknown	36.8	15.4	2536	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
332	50	Tens	RT	0.00	13780	Unknown	126.8	Unknown	40.3	17.8	3990	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
333	50	Tens	RT	0.00	14040	Unknown	126.3	Unknown	41.4	17.8	3930	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
334	50	Tens	RT	0.00	13800	Unknown	124.1	Unknown	39.0	15.3	3195	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
335	50	Tens	RT	0.00	13920	Unknown	123.0	Unknown	40.2	17.3	4056	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
336	50	Tens	RT	0.00	13980	Unknown	124.9	Unknown	42.2	18.1	3268	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
337	50	Tens	RT	0.00	13700	Unknown	126.3	Unknown	41.4	17.8	4096	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
338	50	Tens	RT	0.00	13810	Unknown	124.1	Unknown	39.0	15.3	3196	Br, Ten-clev	Gardo et. al [1-38]	"Inference fl, no bushing
339	50	Tens	RT	0.00	13980	Unknown	125.0	Unknown	42.7	18.4	6346	Tens	Gardo et. al [1-38]	"Inference fl, with bushing
340	50	Tens	RT	0.00	13160	Unknown	120.2	Unknown	42.7	18.4	6710	Tens	Gardo et. al [1-38]	"Inference fl, no bushing
341	50	Tens	RT	0.00	13700	Unknown	125.1	Unknown	44.4	19.1	6300	Tens	Gardo et. al [1-38]	"Inference fl, no bushing
342	50	Tens	RT	0.00	12680	Unknown	126.9	Unknown	41.1	17.7	6300	Tens	Gardo et. al [1-38]	"Inference fl, no bushing



P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD		
336	50	Tens	Sta	0.00	126.80	Unknown	127.9	Unknown	41.8	17.9	5430	Tens	Carbo et al [1-38]	"Interference fit, with bushing"		
337	50	Tens	Sta	0.00	129.20	Unknown	126.0	Unknown	41.0	17.6	5390	Tens	Carbo et al [1-38]	"Interference fit, with bushing"		
338	50	Tens	Sta	0.00	128.10	Unknown	127.5	Unknown	42.0	18.0	5630	Tens	Carbo et al [1-38]	"Interference fit, no bushing"		
339	50	Tens	Sta	0.00	122.40	Unknown	124.7	Unknown	40.1	17.2	Gage failed		Carbo et al [1-38]	"Interference fit, no bushing"		
340	50	Tens	Sta	250	0.84	102.00	Unknown	107.8	Unknown	35.1	15.1	4860	Bear	Carbo et al [1-38]	"Interference fit, no bushing"	
341	50	Tens	Sta	250	0.83	104.00	Unknown	107.8	Unknown	35.1	15.1	4355	Bear	Carbo et al [1-38]	"Interference fit, no bushing"	
342	50	Tens	Sta	250	0.89	119.80	Unknown	115.2	Unknown	37.6	16.2	6050	Bt, Sh	Carbo et al [1-38]	"Interference fit, no bushing"	
343	50	Tens	Sta	250	0.81	1115.00	Unknown	117.2	Unknown	36.9	16.4	6205	Bt, Tens	Carbo et al [1-38]	"Interference fit, no bushing"	
344	50	Tens	Sta	250	0.85	105.00	Unknown	105.9	Unknown	34.1	14.7	4295	Bear	Carbo et al [1-38]	"Interference fit, no bushing"	
345	50	Tens	Sta	250	0.86	109.00	Unknown	112.0	Unknown	36.9	15.5	5100	Bt, Sh	Carbo et al [1-38]	"Interference fit, no bushing"	
346	50	Tens	Sta	250	0.88	108.00	Unknown	105.7	Unknown	34.0	14.8	4390	Bt, Sh	Carbo et al [1-38]	"Interference fit, no bushing"	
347	50	Tens	Sta	250	0.89	110.00	Unknown	107.5	Unknown	34.6	14.9	4695	Bt, Sh	Carbo et al [1-38]	"Interference fit, no bushing"	
348	50	Tens	Sta	0.00	13.65	00	Unknown	121.2	Unknown	40.6	17.5	4080	Bt, Sh	Carbo et al [1-38]	"Bolt inst. & remov. 100 times, Bush"	
349	50	Tens	Sta	0.00	14.64	00	Unknown	133.3	Unknown	44.2	19.1	4245	Bt, Tenclev	Carbo et al [1-38]	"Bolt inst. & remov. 100 times, Bush"	
350	50	Tens	Sta	0.00	13.70	00	Unknown	124.7	Unknown	41.4	17.8	3935	Bt, Tenclev	Carbo et al [1-38]	"Bolt inst. & remov. 100 times, Bush"	
351	50	Tens	Sta	0.00	12.00	00	Unknown	109.3	Unknown	36.2	15.6	3420	Bt, Tenclev	Carbo et al [1-38]	"Bolt inst. & remov. 100 times, Bush"	
352	50	Tens	Sta	0.00	14.00	00	Unknown	132.8	Unknown	44.2	19.0	4230	Bt, Sh	Carbo et al [1-38]	"Bolt inst. & remov. 100 times, Bush"	
353	50	Tens	Sta	0.00	13.58	00	Unknown	128.5	Unknown	42.7	18.4	3925	Bt, Sh	Carbo et al [1-38]	"Bolt inst. & remov. 100 times, Bush"	
354	50	Tens	Sta	0.00	13.00	00	Unknown	128.7	Unknown	42.2	18.1	4150	Bt, Sh	Carbo et al [1-38]	"Bolt inst. & remov. 100 times, Bush"	
355	50	Camp	Sta	0.00	13.80	00	Unknown	129.0	Unknown	42.9	18.4	4030	Bt, Tenclev	Carbo et al [1-38]	"Severe delamination, test, with bush, Bush"	
356	50	Camp	Sta	0.90	14.70	00	Unknown	137.7	Unknown	46.4	19.9	4850	Bear	Carbo et al [1-38]	"Moderate delam., test, with bush,"	
357	50	Camp	Sta	0.94	15.00	00	Unknown	136.8	Unknown	46.2	19.8	4540	Bt, Comp, outside in	Carbo et al [1-38]	"Moderate delam., test, with bush,"	
358	50	Camp	Sta	0.95	13.50	00	Unknown	121.1	Unknown	40.8	17.5	4030	Bear	Carbo et al [1-38]	"Moderate delam., test, with bush,"	
359	50	Camp	Sta	0.86	14.12	00	Unknown	135.7	Unknown	45.5	19.5	4360	Bear	Carbo et al [1-38]	"Moderate delam., test, with bush,"	
360	50	Camp	Sta	0.98	14.30	00	Unknown	127.0	Unknown	42.2	18.3	4980	Bear	Carbo et al [1-38]	"Severe delamination, test, with bush,"	
361	50	Camp	Sta	0.88	12.80	00	Unknown	126.6	Unknown	42.1	18.1	4600	Bear	Carbo et al [1-38]	"Severe delamination, test, with bush,"	
362	50	Camp	Sta	0.84	13.20	00	Unknown	123.4	Unknown	41.6	17.7	4480	Bt, Comp, outside in	Carbo et al [1-38]	"Severe delamination, test, with bush,"	
363	50	Camp	Sta	0.90	13.94	00	Unknown	131.8	Unknown	44.2	19.0	4280	Bear	Carbo et al [1-38]	"Severe delamination, test, with bush,"	
364	50	Camp	Sta	250	0.94	11.20	00	Unknown	106.9	Unknown	36.0	15.5	3875	Bear	Carbo et al [1-38]	"Moderate delam., test, with bush,"
365	50	Camp	Sta	250	1.01	11.55	00	Unknown	101.7	Unknown	34.5	14.7	4020	Bt, Comp, outside in	Carbo et al [1-38]	"Moderate delam., test, with bush,"
366	50	Camp	Sta	250	0.97	10.40	00	Unknown	92.1	Unknown	30.9	13.4	3800	Bt, Comp, outside in	Carbo et al [1-38]	"Moderate delam., test, with bush,"
367	50	Camp	Sta	250	1.00	10.28	00	Unknown	92.3	Unknown	31.2	13.4	3750	Bt, Comp, outside in	Carbo et al [1-38]	"Moderate porosity, with bushing"
368	50	Camp	Sta	250	0.92	10.20	00	Unknown	94.4	Unknown	31.5	13.5	4275	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"
369	50	Camp	Sta	250	0.89	11.00	00	Unknown	104.4	Unknown	34.6	14.5	3605	Bt, Comp, outside in	Carbo et al [1-38]	"Severe porosity, with bushing"
370	50	Camp	Sta	250	0.83	9.60	00	Unknown	93.8	Unknown	31.2	13.4	3180	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"
371	50	Camp	Sta	250	0.94	10.79	00	Unknown	98.3	Unknown	32.8	14.1	3445	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"
372	50	Camp	Sta	0.89	12.58	00	Unknown	115.8	Unknown	39.0	18.8	3840	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"	
373	50	Camp	Sta	1.02	13.50	00	Unknown	124.7	Unknown	41.4	17.9	4280	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"	
374	50	Camp	Sta	1.11	13.42	00	Unknown	117.2	Unknown	39.0	18.8	4365	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"	
375	50	Camp	Sta	0.99	13.14	00	Unknown	119.1	Unknown	39.8	17.2	4070	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"	
376	50	Camp	Sta	250	0.94	10.79	00	Unknown	122.0	Unknown	41.0	17.6	4130	Bear	Carbo et al [1-38]	"Moderate porosity, with bushing"
377	50	Camp	Sta	0.98	14.08	00	Unknown	128.7	Unknown	43.7	18.7	4605	Bear	Carbo et al [1-38]	"Moderate porosity, with bushing"	
378	50	Camp	Sta	1.02	13.55	00	Unknown	132.7	Unknown	45.1	19.4	4825	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"	
379	50	Camp	Sta	0.99	14.10	00	Unknown	130.6	Unknown	44.0	18.9	4140	Bear	Carbo et al [1-38]	"Moderate porosity, with bushing"	
380	50	Camp	Sta	250	1.00	6.42	00	Unknown	55.7	Unknown	19.8	8.1	1975	Comp, outside in	Carbo et al [1-38]	"Severe porosity, with bushing"
381	50	Camp	Sta	250	0.98	7.26	00	Unknown	67.2	Unknown	22.4	9.7	2430	Comp, outside in	Carbo et al [1-38]	"Severe porosity, with bushing"
382	50	Camp	Sta	250	0.98	8.98	00	Unknown	81.7	Unknown	27.2	11.7	2975	Bear	Carbo et al [1-38]	"Severe porosity, with bushing"
383	50	Camp	Sta	1.01	9.14	00	Unknown	83.5	Unknown	27.9	12.0	3060	Br, Comp, outside in	Carbo et al [1-38]	"Severe porosity, with bushing"	
384	50	Camp	Sta	260	0.96	9.78	00	Unknown	88.9	Unknown	29.8	12.8	3180	Bear	Carbo et al [1-38]	"Moderate porosity, with bushing"
385	50	Camp	Sta	250	1.00	10.00	00	Unknown	92.1	Unknown	31.1	13.3	3180	Bear	Carbo et al [1-38]	"Moderate porosity, with bushing"
386	50	Camp	Sta	250	1.01	10.30	00	Unknown	92.4	Unknown	31.0	13.3	3165	Br, Comp, outside in	Carbo et al [1-38]	"Moderate porosity, with bushing"
387	50	Camp	Sta	250	1.00	9.66	00	Unknown	87.2	Unknown	29.3	12.6	3050	Bear	Carbo et al [1-38]	"Moderate porosity, with bushing"
388	50	Camp	Sta	250	1.01	9.68	00	Unknown	93.7	Unknown	31.4	13.5	2970	Bear	Carbo et al [1-38]	"Tiled Csk away bear, surface, Bu."
389	50	Camp	Sta	250	0.98	9.88	00	Unknown	90.9	Unknown	30.4	13.1	3030	Br, Comp, outside in	Carbo et al [1-38]	"Tiled Csk away bear, surface, Bu."
390	50	Camp	Sta	250	0.88	9.50	00	Unknown	91.0	Unknown	30.3	13.0	2690	Bear	Carbo et al [1-38]	"Tiled Csk away bear, surface, Bu."
391	50	Camp	Sta	250	0.93	9.14	00	Unknown	91.1	Unknown	30.4	13.1	3285	Bear	Carbo et al [1-38]	"Tiled Csk away bear, surface, Bu."



P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	
392	50	Camp	0.92	10220	Unknown	91.2	Unknown	31.6	—	13.5	3145	Bear	Gurbo et al [1-36]	"Tilted Cat towed bear surface; Bu.	
393	50	Camp	250	0.90	10020	Unknown	93.4	Unknown	31.2	—	13.4	3095	Bear	Gurbo et al [1-38]	"Tilted Cat towd. bear. surface; Bu.
394	50	Camp	250	0.90	9550	Unknown	91.4	Unknown	30.5	13.1	2770	Br. Comp. outside ho.	Gurbo et al [1-36]	"Tilted Cat towd. bear. surface; Bu.	
395	50	Camp	250	0.86	9280	Unknown	92.0	Unknown	30.6	13.2	2580	Bear	Gurbo et al [1-38]	"Tilted Cat towd. bear. surface; Bu.	
396	50	Camp	250	0.92	11060	Unknown	99.9	Unknown	23.6	14.4	3910	Br. Comp. outside ho.	Gurbo et al [1-36]	"Bolt inst & remv. 100 times; Bush.	
397	50	Camp	250	1.01	10350	Unknown	92.6	Unknown	31.2	13.3	3585	Br. Comp. outside ho.	Gurbo et al [1-38]	"Both inst & remv. 100 times; Bush.	
398	50	Camp	250	0.87	10030	Unknown	93.1	Unknown	31.6	13.6	3215	Br. Comp. outside ho.	Gurbo et al [1-36]	"Both inst & remv. 100 times; Bush.	
399	50	Camp	250	1.01	9810	Unknown	85.0	Unknown	30.0	12.8	3230	Br. Comp. outside ho.	Gurbo et al [1-38]	"Both inst & remv. 100 times; Bush.	
400	100	Tens	RT	0.00	9490	134.4	—	44.8	19.2	—	Br. Spill	Sh. Spill Del	Ramkumar... [1-37]		
401	100	Tens	RT	0.00	9550	114.7	136.3	38.21	45.1	19.3	—	4182	Br. Spill	Ramkumar... [1-37]	
402	100	Tens	RT	0.00	9485	134.0	—	44.6	19.1	—	—	—	—	—	
403	100	Tens	RT	0.00	9599	134.7	—	44.9	19.2	—	Br. Spill	Sh. Spill	Ramkumar... [1-37]		
404	100	Tens	RT	0.00	9135	109.5	128.2	36.47	42.7	18.3	4064	Br. Spill	Ramkumar... [1-37]		
405	100	Tens	RT	0.00	9492	136.6	—	45.2	19.4	—	Br. Spill	Sh. Spill	Ramkumar... [1-37]		
406	100	Tens	RT	0.00	9326	87.8	134.9	29.25	44.9	19.3	4197	Br. Spill	Ramkumar... [1-37]		
407	100	Tens	RT	0.00	9831	139.2	—	46.4	19.9	—	Br. Del	Sh. Del	Ramkumar... [1-37]		
408	100	Tens	RT	0.00	8195	108.1	121.4	36.03	40.4	17.3	2946	Sh. Del	Ramkumar... [1-37]		
409	100	Tens	RT	0.00	7706	114.2	—	38.0	38.0	16.3	Sh. Del	Sh. Del	Ramkumar... [1-37]		
410	100	Tens	RT	0.00	7855	117.5	—	39.1	16.8	—	Sh. Del	Sh. Del	Ramkumar... [1-37]		
411	100	Tens	RT	0.00	9387	117.7	141.4	39.22	47.1	20.2	6675	Br. Spill	Ramkumar... [1-37]		
412	100	Tens	RT	0.00	9897	146.4	—	48.8	20.9	—	Tens. Del	Br. Del	Ramkumar... [1-37]		
413	100	Tens	RT	0.00	7697	116.2	—	38.7	16.6	—	Br. Spill	Sh. Spill	Ramkumar... [1-37]		
414	100	Tens	RT	0.00	9399	141.9	—	47.3	20.3	—	Sh. Del	Sh. Del	Ramkumar... [1-37]		
415	100	Tens	RT	0.00	8911	112.3	125.1	37.41	41.7	17.9	3611	Br. Spill	Ramkumar... [1-37]		
416	100	Tens	RT	0.00	8813	123.7	—	41.2	17.7	—	3648	Sh. Del	Ramkumar... [1-37]		
417	100	Comp	RT	0.00	9324	88.4	116.9	28.46	38.9	16.7	3699	Br. Spill	Ramkumar... [1-37]		
418	100	Comp	RT	0.00	9233	128.5	—	42.8	18.4	—	Br. Spill	Sh. Spill	Ramkumar... [1-37]		
419	100	Comp	RT	0.00	9301	-130.5	—	-43.5	-18.6	—	Br. Spill	Sh. Spill	Ramkumar... [1-37]		
420	100	Tens	RT	0.00	8898	77.2	124.9	25.72	41.6	17.8	3801	Clev. Del	Ramkumar... [1-37]		
421	100	Tens	RT	0.00	1054	148.7	—	48.9	21.0	—	Tens	Br. Spill	Ramkumar... [1-37]		
422	100	Tens	RT	0.00	9438	132.5	—	44.1	18.9	—	Clev. Del	Br. Spill	Ramkumar... [1-37]		
423	100	Tens	RT	0.00	9819	103.4	135.4	34.46	45.1	19.3	4583	Bear	Ramkumar... [1-37]		
424	100	Tens	RT	2.8	0.70	9809	138.9	—	46.3	19.8	—	Bear	Sh. Del	Ramkumar... [1-37]	
425	100	Tens	RT	2.8	0.70	9760	133.5	—	44.5	19.1	—	Comp offset ho	Br. Spill	Ramkumar... [1-37]	
426	100	Tens	RT	2.8	0.70	6414	83.7	90.8	21.23	30.3	13.0	Gage failed	Br. Spill	Ramkumar... [1-37]	
427	100	Tens	RT	2.8	0.70	7445	105.4	—	36.1	15.1	—	Br. Spill	Br. Spill	Ramkumar... [1-37]	
428	100	Tens	RT	2.8	0.70	7455	102.8	—	34.3	14.7	—	3502	Br. Spill	Ramkumar... [1-37]	
429	100	Comp	RT	2.8	0.70	-7318	-102.7	—	-34.2	-14.7	—	4583	Bear	Ramkumar... [1-37]	
430	100	Comp	RT	2.8	0.70	-7332	-104.8	—	34.9	-15.0	—	Comp offset ho	Br. Spill	Ramkumar... [1-37]	
431	100	Tens	RT	2.8	0.70	-8286	-87.7	-115.4	-29.20	-38.4	-16.5	7 ... offset ho	Br. Spill	Ramkumar... [1-37]	
432	0	Tens	RT	0.00	8388	122.0	—	40.6	17.4	—	Br. Spill	Br. Spill	Ramkumar... [1-37]		
433	0	Tens	RT	0.00	7992	111.2	—	47.3	15.9	—	Br. Spill	Br. Spill	Ramkumar... [1-37]		
434	0	Tens	RT	0.00	9170	94.6	127.6	31.52	42.5	18.2	4194	Sh. Del	Ramkumar... [1-37]		
435	0	Tens	RT	0.00	8798	124.6	—	41.5	17.8	—	Br. Spill	Sh. Del	Ramkumar... [1-37]		
436	200	Tens	RT	0.00	10198	144.4	—	48.1	20.6	—	Tens	Br. Spill	Ramkumar... [1-37]		
437	200	Tens	RT	0.00	10801	147.5	—	49.1	21.1	—	Br. Spill	Br. Spill	Ramkumar... [1-37]		
438	200	Tens	RT	0.00	9339	111.3	136.9	37.08	46.6	19.6	4198	Br. Spill	Ramkumar... [1-37]		
439	200	Tens	RT	0.00	10779	148.4	—	49.4	21.2	—	Br. Spill	Br. Spill	Ramkumar... [1-37]		
440	100	Tens	RT	0.00	8439	106.2	119.5	35.38	39.9	19.9	3632	Clev. Del	Ramkumar... [1-37]		
441	100	Tens	RT	0.00	9330	132.1	—	44.0	22.0	—	Sh. Spill	Sh. Spill	Ramkumar... [1-37]		
442	100	Tens	RT	0.00	9306	131.8	—	43.9	22.9	—	Clev. Del	Br. Spill	Ramkumar... [1-37]		
443	100	Tens	RT	0.00	8219	107.1	114.4	35.69	38.1	22.9	3048	Clev. Del	Ramkumar... [1-37]		
444	100	Tens	RT	0.00	8903	127.2	—	42.4	25.4	—	Clev. Del	Br. Spill	Ramkumar... [1-37]		
445	100	Tens	RT	0.00	9169	132.5	—	44.1	26.5	—	Clev. Del	Br. Spill	Ramkumar... [1-37]		
446	100	Tens	RT	0.00	8448	96.7	98.4	31.88	32.1	19.3	2371	Sh. Spill	Ramkumar... [1-37]		
447	100	Tens	RT	0.00	6776	101.4	—	33.8	20.3	19.3	Sh. Spill	Sh. Spill	Ramkumar... [1-37]		



P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	
448	100	Tens	RT	0.00	6815	111.7	104.8	34.9	21.0	Sh, Spi, Del	Ramkumar, ...	[1-37]			
449	100	Tens	RT	0.00	8534	128.8	37.21	42.9	25.8	Sh, Del	Ramkumar, ...	[1-37]			
450	100	Tens	RT	0.00	9989	134.4		44.8	26.9	Sh, Del	Ramkumar, ...	[1-37]			
451	100	Tens	RT	0.00	9180	139.6		46.5	27.9	Sh, Del	Ramkumar, ...	[1-37]			
452	100	Tens	RT	0.00	18149	93.6	127.0	37.42	49.2	17.6	5154	Tens, Del			
453	100	Tens	RT	0.00	18271	124.9		50.6	17.8	Sh, Del	Ramkumar, ...	[1-37]			
454	100	Tens	RT	0.00	14973	103.3		41.3	14.8	Clev, Del	Ramkumar, ...	[1-37]			
455	100	Tens	RT	0.00	15950	99.3	110.0	39.72	44.0	4424	Tens	Ramkumar, ...	[1-37]		
456	100	Tens	RT	0.00	14863		102.5	41.0	14.6	Tens	Ramkumar, ...	[1-37]			
457	100	Tens	RT	0.00	16805	116.9		46.8	18.7	Sh, Del	Ramkumar, ...	[1-37]			
458	100	Tens	RT	0.70	18271	101.9	124.9	40.75	50.0	5342	Sh, Del, Clev	Ramkumar, ...	[1-37]		
459	100	Tens	RT	0.70	17831	123.0		49.2	17.6	Sh, Del, Clev	Ramkumar, ...	[1-37]			
460	100	Tens	RT	0.70	18173	124.3		49.7	17.8	Sh, Del, Clev	Ramkumar, ...	[1-37]			
461	100	Tens	RT	0.00	15645	87.7	108.8	35.06	42.5	4377	Clev, Del	Ramkumar, ...	[1-37]		
462	100	Tens	RT	0.00	15048		104.7	41.9	15.0	Clev, Del	Ramkumar, ...	[1-37]			
463	100	Tens	RT	0.00	14631	100.0		40.0	14.3	Clev, Del	Ramkumar, ...	[1-37]			
464	100	Tens	RT	0.00	14438	111.0		44.4	15.9	3327	Sh, Del	Ramkumar, ...	[1-37]		
465	100	Tens	RT	0.00	16268	123.9		49.6	17.7	Sh, Del	Ramkumar, ...	[1-37]			
466	100	Tens	RT	0.00	14118	107.6		43.0	15.4	Sh, Del	Ramkumar, ...	[1-37]			
467	100	Tens	RT	0.00	17123	129.2		51.7	18.5	6626	Tens, Del	Ramkumar, ...	[1-37]		
468	100	Tens	RT	0.00	16231	122.5		49.0	17.5	Tens, Del	Ramkumar, ...	[1-37]			
469	100	Tens	RT	0.00	15975	108.4	119.9	43.36	47.8	17.1	Ter-clav, Del	Ramkumar, ...	[1-37]		
470	100	Tens	RT	0.00	15095	99.1	106.9	44.04	47.8	4694	Ter-clav, Del	Ramkumar, ...	[1-37]		
471	100	Tens	RT	0.00	13481	94.8		42.0	15.8	Ter-clav, Del	Ramkumar, ...	[1-37]			
472	100	Tens	RT	0.00	15254	107.0		47.8	17.8	Tens, Del	Ramkumar, ...	[1-37]			
473	100	Comp	RT	0.00	17029	-88.1	-115.4	-35.25	-46.2	-19.2	Comp, offset, hot	Ramkumar, ...	[1-37]		
474	100	Comp	RT	0.00	15928	-109.8	-109.8	-33.9	-33.9	-18.3	Neu Scl, Comp	Ramkumar, ...	[1-37]		
475	100	Comp	RT	0.00	17860	-120.8	-120.8	-48.3	-48.3	-20.1	Comp, offset, hot	Ramkumar, ...	[1-37]		
476	100	Tens	RT	0.00	18222	132.5		55.2	18.4	4470	Tens	Ramkumar, ...	[1-37]		
477	100	Tens	RT	0.00	18222	111.3		44.4	15.5	Tens	Ramkumar, ...	[1-37]			
478	100	Tens	RT	0.00	17611	110.9		46.2	15.4	Tens	Ramkumar, ...	[1-37]			
479	100	Tens	RT	0.00	16498	112.7	114.7	46.96	47.8	4177	Tens	Ramkumar, ...	[1-37]		
480	100	Tens	RT	0.00	17440	116.8		48.6	16.2	Tens	Ramkumar, ...	[1-37]			
481	100	Tens	RT	0.00	15804	109.0		45.4	15.1	Tens	Ramkumar, ...	[1-37]			
482	100	Tens	RT	0.00	15779	109.3		45.5	15.2	Tens	Ramkumar, ...	[1-37]			
483	100	Tens	RT	0.00	15720	109.4		45.6	15.2	Tens	Ramkumar, ...	[1-37]			
484	100	Tens	RT	0.00	15486	106.8		44.6	14.8	Tens	Ramkumar, ...	[1-37]			
485	250	Tens	RT	0.00	15315	106.1		44.2	14.7	Tens	Ramkumar, ...	[1-37]			
486	250	Tens	RT	0.00	14802	103.0		42.9	14.3	Tens	Ramkumar, ...	[1-37]			
487	250	Tens	RT	0.00	14729	100.3		41.8	13.9	Tens	Ramkumar, ...	[1-37]			
488	6	Tens	RT	Unknown	5368	Unknown	57.4	Unknown	14.2	14.2	Tens, Sh, Br	Pryer, Matthews1-3, G1	is Shienka, Resin supplier:Shell		
489	6	Tens	RT	Unknown	4768	Unknown	89.1	Unknown	32.9	16.52	Unknown	Cheng, Scott, [1-40]	Data is an average of 3 spec.		
490	6	Tens	RT	Unknown	6698	Unknown	88.4	Unknown	21.5	14.90	Unknown	Tens, Bear	Pryer, Matthews1-3, G1	is Shienka, Resin supplier:Shell	
491	6	Tens	RT	Unknown	5937	Unknown	95.0	Unknown	39.0	16.83	Unknown	Cheng, Scott, [1-40]	Data is an average of 4 spec.		
492	6	Tens	RT	Unknown	4376	Unknown	70.0	Unknown	26.8	10.7	Unknown	Bear, Tens	Pryer, Matthews1-3, G1	is Shienka, Resin supplier:Shell	
493	6	Tens	RT	Unknown	5841	Unknown	80.5	Unknown	32.5	13.9	Unknown	Cheng, Scott, [1-40]	Data is an average of 4 spec.		
494	0	Tens	RT	Unknown	6122	Unknown	86.1	Unknown	33.5	12.37	Unknown	Tens	Pryer, Matthews1-3, Loading rate = .02 in/min		
495	0	Tens	RT	Unknown	6196	Unknown	89.1	Unknown	32.9	16.08	Unknown	Tens	Cheng, Scott, [1-40]	Data is an average of 4 spec.	
496	0	Tens	RT	Unknown	6210	Unknown	83.7	Unknown	23.0	13.95	Unknown	Tens, Bear	Cheng, Scott, [1-40]	Data is an average of 4 spec.	
497	0	Tens	RT	Unknown	6778	Unknown	82.8	Unknown	21.4	13.80	Unknown	Sh, Tens	Cheng, Scott, [1-40]	Data is an average of 4 spec.	
498	0	Tens	RT	Unknown	4860	Unknown	79.2	Unknown	20.4	13.20	Unknown	Sh, Tens	Cheng, Scott, [1-40]	Data is an average of 4 spec.	
499	0	Tens	RT	Unknown	2988	Unknown	47.3	Unknown	18.2	7.89	Unknown	Tens	Cheng, Scott, [1-40]	Data is an average of 3 spec.	

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
504 T300/1034-C 0/100/0	((±45)16)s 0/100/0	1.943	0.125	0.250	0.751 x 2	1.25	N/A	3.986	3.000	Sym.	0.25	Pin		
505 T300/1034-C 0/100/0	((±45)16)s 0/100/0	1.929	0.125	0.250	0.751 x 2	0.75	N/A	3.858	3.000	Sym.	0.25	Pin		
506 T300/1034-C ((0±45/90)3)s	((0±45/90)3)s 25/50/25	0.513	0.125	0.250	0.3752 x 1	N/A	0.375	2.052	1.500	Sym.	0.25	Pin		
507 T300/1034-C 25/50/25	((0±45/90)3)s ((0±45/90)3)s	0.628	0.125	0.250	0.3752 x 1	N/A	0.625	2.512	1.500	Sym.	0.25	Pin		
508 T300/1034-C 25/50/25	((0±45/90)3)s ((0±45/90)3)s	0.711	0.125	0.250	0.752 x 1	N/A	0.75	2.844	3.000	Sym.	0.25	Pin		
509 T300/1034-C 25/50/25	((0±45/90)3)s ((0±45/90)3)s	0.714	0.125	0.250	0.752 x 1	N/A	1.25	2.858	3.000	Sym.	0.25	Pin		
510 T300/1034-C 25/50/25	((0±45/90)3)s ((0±45/90)3)s	1.208	0.125	0.250	0.752 x 1	N/A	0.75	4.824	3.000	Sym.	0.25	Pin		
511 T300/1034-C 25/50/25	((0±45/90)3)s N/A	1.211	0.125	0.250	0.752 x 1	N/A	1.25	4.844	3.000	Sym.	0.25	Pin		
512 T300/1034-C N/A	((0)12±60±30)2)s N/A	0.507	0.125	0.250	0.3752 x 1	N/A	0.375	2.028	1.500	Sym.	0.25	Pin		
513 T300/1034-C N/A	((0)12±60±30)2)s N/A	0.629	0.125	0.250	0.3752 x 1	N/A	0.625	2.516	1.500	Sym.	0.25	Pin		
514 T300/1034-C N/A	((0)12±60±30)2)s N/A	0.672	0.125	0.250	0.752 x 1	N/A	0.75	2.888	3.000	Sym.	0.25	Pin		
515 T300/1034-C N/A	((0)12±60±30)2)s N/A	0.727	0.125	0.250	0.752 x 1	N/A	1.25	2.908	3.000	Sym.	0.25	Pin		
516 T300/1034-C N/A	((0)12±60±30)2)s N/A	1.208	0.125	0.250	0.752 x 1	N/A	0.75	4.832	3.000	Sym.	0.25	Pin		
517 T300/1034-C N/A	((0)12±60±30)2)s N/A	1.161	0.125	0.250	0.752 x 1	N/A	1.25	4.644	3.000	Sym.	0.25	Pin		
518 T300/1034-C 50/0/50	((0)90)6)s ((0)90)6)s	0.637	0.125	0.250	0.3752 x 1	N/A	0.375	2.548	1.500	Sym.	0.25	Pin		
519 T300/1034-C 50/0/50	((0)90)6)s ((0)90)6)s	0.639	0.125	0.250	0.3752 x 1	N/A	0.625	2.556	1.500	Sym.	0.25	Pin		
520 T300/1034-C 50/0/50	((0)90)6)s ((0)90)6)s	0.751	0.125	0.250	0.752 x 1	N/A	0.75	3.004	3.000	Sym.	0.25	Pin		
521 T300/1034-C 50/0/50	((0)90)6)s ((0)90)6)s	0.75	0.125	0.250	0.752 x 1	N/A	1.25	3.000	3.000	Sym.	0.25	Pin		
522 T300/1034-C 50/0/50	((0)90)6)s ((0)90)6)s	1.258	0.125	0.250	0.752 x 1	N/A	0.75	3.032	3.000	Sym.	0.25	Pin		
523 T300/1034-C 50/0/50	((0)90)6)s ((0)90)6)s	1.257	0.125	0.250	0.752 x 1	N/A	1.25	5.028	3.000	Sym.	0.25	Pin		
524 T300/1034-C 0/100/0	((±45)16)s 0/100/0	0.514	0.125	0.250	0.3752 x 1	N/A	0.375	2.056	1.500	Sym.	0.25	Pin		
525 T300/1034-C 0/100/0	((±45)16)s 0/100/0	0.617	0.125	0.250	0.3752 x 1	N/A	0.625	2.468	1.500	Sym.	0.25	Pin		
526 T300/1034-C 0/100/0	((±45)16)s 0/100/0	0.682	0.125	0.250	0.752 x 1	N/A	0.75	2.728	3.000	Sym.	0.25	Pin		
527 T300/1034-C 0/100/0	((±45)16)s 0/100/0	0.707	0.125	0.250	0.752 x 1	N/A	1.25	2.828	3.000	Sym.	0.25	Pin		
528 T300/1034-C 0/100/0	((±45)16)s 0/100/0	1.198	0.125	0.250	0.752 x 1	N/A	0.75	4.784	3.000	Sym.	0.25	Pin		
529 T300/1034-C 0/100/0	((±45)16)s 0/100/0	1.204	0.125	0.250	0.752 x 1	N/A	1.25	4.816	3.000	Sym.	0.25	Pin		

## Multiple Joints

P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
504	0.0	Tens	RT	Unknown	3325	Unknown	53.2	Unknown	13.7	8.87	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
505	0.0	Tens	RT	Unknown	3377	Unknown	54.2	Unknown	14.0	9.01	Unknown	Tens, Br	Chang, Scott..[-40]	Data is an average of 4 spec.
506	0.0	Tens	RT	Unknown	2730	Unknown	43.7	Unknown	42.6	14.6	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
507	0.0	Tens	RT	Unknown	2860	Unknown	45.8	Unknown	36.4	11.4	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
508	0.0	Tens	RT	Unknown	3052	Unknown	48.8	Unknown	34.3	8.1	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 2 spec.
509	0.0	Tens	RT	Unknown	3125	Unknown	50.0	Unknown	36.0	6.3	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
510	0.0	Tens	RT	Unknown	5405	Unknown	86.5	Unknown	35.9	14.4	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
511	0.0	Tens	RT	Unknown	5612	Unknown	93.0	Unknown	38.4	11.6	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
512	0.0	Tens	RT	Unknown	2005	Unknown	32.1	Unknown	31.6	10.7	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
513	0.0	Tens	RT	Unknown	2355	Unknown	37.7	Unknown	30.0	9.4	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
514	0.0	Tens	RT	Unknown	2136	Unknown	34.2	Unknown	25.4	5.7	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 3 spec.
515	0.0	Tens	RT	Unknown	2412	Unknown	38.6	Unknown	26.5	4.8	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
516	0.0	Tens	RT	Unknown	3866	Unknown	81.9	Unknown	25.6	10.3	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 3 spec.
517	0.0	Tens	RT	Unknown	3887	Unknown	62.2	Unknown	26.8	7.8	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
518	0.0	Tens	RT	Unknown	2560	Unknown	41.0	Unknown	32.2	13.7	Unknown	Sh, Sh, Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
519	0.0	Tens	RT	Unknown	3191	Unknown	51.1	Unknown	39.9	12.8	Unknown	Sh, Sh, Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
520	0.0	Tens	RT	Unknown	3725	Unknown	59.6	Unknown	39.7	9.9	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
521	0.0	Tens	RT	Unknown	4145	Unknown	66.3	Unknown	44.2	8.3	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
522	0.0	Tens	RT	Unknown	4862	Unknown	77.9	Unknown	30.9	13.0	Unknown	Sh, Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
523	0.0	Tens	RT	Unknown	5616	Unknown	89.9	Unknown	35.7	11.2	Unknown	Br, Sh	Chang, Scott..[-40]	Data is an average of 3 spec.
524	0.0	Tens	RT	Unknown	1380	Unknown	22.1	Unknown	21.5	7.4	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 3 spec.
525	0.0	Tens	RT	Unknown	1522	Unknown	24.4	Unknown	19.7	6.1	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
526	0.0	Tens	RT	Unknown	1480	Unknown	23.7	Unknown	17.4	3.0	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
527	0.0	Tens	RT	Unknown	1600	Unknown	24.0	Unknown	17.0	3.0	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
528	0.0	Tens	RT	Unknown	3362	Unknown	69.8	Unknown	22.5	9.0	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.
529	0.0	Tens	RT	Unknown	3412	Unknown	64.8	Unknown	22.7	6.8	Unknown	Tens	Chang, Scott..[-40]	Data is an average of 4 spec.

**Appendix B-1. Adhesive properties.**

## Bulk-Adj

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1 Adhesive	Adhesive	Testing	Load Rate	Initial Young's Modulus	Poisson's Ratio	Initial Shear Modulus	Elastic	Final Limit of Secant	Ultimate Strength, ksi	Tensile Strength, ksi	Ultimate Strain %	Compress. Strength, ksi	
2	Thickness in.	Tempa- ture °F or ^(%S) E, ksi	in./min.	Modulus Y	Ratio	Modulus G, ksi	E(0), ksi	G(0), ksi	E(US), ksi	G(US), ksi	4.93	8.3	
3	Redux K-6	FM		500.00	0.360	184.00	5.45	5					
4	AF-6	FM		18.20	0.494	6.10		3.71		6.25			
5	AF-6	FM		9.50	0.490	3.20	1.68				2.4		
6	MN3C	FM		5.20	0.498	1.53	0.73	2.43		1.36	1.22		
7	Epon VIII	FM		508.00	0.412	180.00		4.75		60.42			
8	Metbond 4021	FM											
9	Metbond 4021	FM		16.20	0.472	5.52	1.3	1.14			2.71		
10	Metbond 4021	FM		6.36	0.497	2.12				2.00			
11	FM 47	FM		325.00	0.385	117.00	3.42	2.33		63.64	4.35		
12	Epon 422J	FM		395.00	0.294	160.00		3.23		99.06	2.56		
13	Metbond 408	FM		139.00	0.410	49.30		1.87		2.39	8		
14	FM 1000	FM		180.00	0.408	64.10		3.4		2.13	6.99		
15	EA 9320 T=118C-394	FM	1.969	340.4	0.354		1.74		170.8		6.83	4	
16	3M EC 2216 AVB T=118C-394	FM	1.969	242.2	0.38		1.59		17.6		4.41	2.5	
17	CB754R221-75 T=118C-394	FM	1.969	37.7	0.075		0.33		3.3		1.12	3.4	
18	Metbond 1113	0.140 FM	^6.81E-4	311.9	0.351		2.9		168.0		6.72	4	
19	Metbond 1113	0.140 FM	^6.83E-3	329.9	0.382		2.9		176.8		7.25	4.1	
20	Metbond 1113	0.140 FM	^3.35E-2	319.9	0.390		2.9				7.49		
21	Metbond 1113	0.140 FM	^6.55E-2	332.9	0.360		2.9		193.2		7.92	4.1	
22	Metbond 1113	0.140 FM	^6.68E-1	329.9	0.370		2.9		253.9		8.38	3.3	
23	Metbond 1113-2	0.140 FM	^7.00E-4	290.9	0.380		2.03		108.8		5.66	5.2	
24	Metbond 1113-2	0.140 FM	^6.75E-3	299.9	0.392		2.03		121.4		6.19	5.1	
25	Metbond 1113-2	0.140 FM	^3.40E-2	280.1	0.357		2.03				6.19		
26	Metbond 1113-2	0.140 FM	^7.05E-2	294.9	0.343		2.03		123.5		6.67	5.4	
27	Metbond 1113-2	0.140 FM	^8.35E-1	299.9	0.366		2.03		149.4		7.77	5.2	
28	Metbond 1113	FM		325	0.366		1.58				7.90		
29	Metbond 1113	FM						36.3					
30	AF 128-2	FM			455	0.300		1.58			12.00		
31	AF 128-2	FM						17.5		0.1			
32	Polyurethane	0.065 FM									3.31		
33	Polyurethane	0.006 FM									4.85		
34	Polyurethane	0.065 FM									5.82		
35	Polyurethane	0.006 FM									5.19		
36	EA 934	0.006 FM									4.09		
37	EA 934	0.023 FM									3.24		
38	EA 934	0.068 FM									2.69		
39	EA 934	0.13 FM									2.05		
40	EA 934	0.525 FM									1.29		

## Bulk-Ad

O	P	Q	R	S	T	U	V	W
1	Ultimate Compress. Strain %	Ultimate Shear	Ramberg- Osgood Para	Ramberg- Osgood Para	Ramberg- Osgood Para	Ramberg- Osgood Para	Testing Methods	Remarks
4	8.2						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
5	3.91						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
6							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
7	2.48						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
8	6.05						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
9							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
10	4.56						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
11	3.72						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
12	5.52						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
13	5.55						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
14	7.93						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
15	30						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
16	39						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
17	45						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
18							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
19							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
20							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
21							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
22							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
23							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
24							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
25							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
26							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
27							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
28	2.039 E-33						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
29	4.39						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
30	2.039 E-33						Kuenzi, Stevens[2-30]	Mati-61S Al alloy
31	13.0						Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
32							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
33							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
34							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
35							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
36							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
37							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
38							Kuenzi, Stevens[2-30]	Mati-61S Al alloy
39							Kuenzi, Stevens[2-30]	Data scatter. 200% - 300%
40							Kuenzi, Stevens[2-30]	Mati-61S Al alloy

## Bulk-Adj

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	N
41	EA 9309.2NA	0.065	FM	0.05											1.42
42	EA 9309.2NA	0.005	FM	0.05											1.62
43	EA 9309.2NA	0.065	FM	0.50											2.43
44	EA 913	0.005	FM	0.05											1.65
45	EA 913	0.005	FM	0.50											3.02
46	EA 9309.2NA	0.005/.065?	FM	0.005											2.64
47	EA 9309.2NA	0.005/.065?	FM	0.05											3.19
48	EA 9309.2NA	0.005/.065?	FM	0.50											3.28
49	EA 9321	0.008	FM												8.54
50	AV128M/HV998	0.008	FM												
51	FM 300K	0.008	FM												
52	FM 300K	0.071	FM												
53	EC 3445	0.004	FM												
54	FM 300	0.009	FM												
55	Redux 322 Ep Film T: .0197-.394	FM													
56	Redux 322 Ep Film S or Tor: 0.071	FM													
57	Ecoboard 45 LV T: .0197-.394	FM													
58	Ecoboard 45 LV S or Tor: 0.071	FM													
59	FM-73M	0.0087	FM												
60	EA 951 Film	0.0108	FM												
61	EA 951 Film	0.0096	FM												
62	EA 951 Film	0.0093	FM												
63	EA 951 Film	0.013	FM												
64	EA 951 Film	0.0127	FM												
65	EA 951 Film	0.0034	FM												
66	EA 951 Film	0.0031	FM												
67	EA 951 Film	0.004	FM												
68	EA 951 Film	0.0034	FM												
69	EA 951 Film	0.0031	FM												
70	EA 951 Film	0.0034	FM												
71	EA 951 Film	0.0012	FM												
72	EA 951 Film	0.0012	FM												
73	EA 951 Film	0.0012	FM												
74	EA 951 Film	0.0012	FM												
75	EA 951 Film	0.0028	FM												
76	EA 951 Film	0.0037	FM												
77	EA 951 Film	0.0025	FM												
78	EA 951 Film	0.0031	FM												
79	EA 951 Film	0.003	FM												
80	EA 951 Film	0.0048	FM												

## Bulk-Adj

O	P	Q	R	S	T	U	V	W
41						Modified button tensile adhesion	Anderson...[2-25]	With Teflon spacer
42						Modified button tensile adhesion	Anderson...[2-25]	Without Teflon spacer
43						Modified button tensile adhesion	Anderson...[2-25]	With Teflon spacer
44						Modified button tensile adhesion	Anderson...[2-25]	Without Teflon spacer
45						Modified button tensile adhesion	Anderson...[2-25]	Without Teflon spacer
46						Modified button tensile adhesion	Anderson...[2-25]	Teflon spacer?
47						Modified button tensile adhesion	Anderson...[2-25]	Teflon spacer?
48						Modified button tensile adhesion	Anderson...[2-25]	Teflon spacer?
49	4.27					Stiff adherend spec.. chromic acid etch	Weisberg, Arcan [2-13] Using COD gage	2670-114
50	7.54					Stiff adherend specimen, sand blast	Weisberg, Arcan [2-13] Using COD gage	2670-114
51						Butt joint & Thick adherend lap sh.	Jangblad...[2-21]	St butt J., Al adherend J.
52						Rectangular adhesive bulk specimen	Jangblad...[2-21]	1=0.071", W=.776"
53						Mail...[2-11]		
54						Mail...[2-11]		
55						Ten. & torsion pendulum on bulk spec.	Jeandreau [2-20]	Ten. NFT 51034, Tor-NFT 51104
56						Ten. Bulk spec.. Sh: thick adherend spec	Jeandreau [2-20]	Ten. NFT 51034, Sh-DIN 5451
57						Ten. & torsion pendulum on bulk spec.	Jeandreau [2-20]	Ten. NFT 51034, Tor-NFT 51104
58						Ten. Bulk spec.. Sh: thick adherend spec	Jeandreau [2-20]	Ten. NFT 51034, Sh-DIN 5451
59	3.92					Thick adherend lap sh. & more inferir Post...[2-32]		Sh is Uniform except 2 ends
60						Thick adherend lap shear	Renton, Vinsen [2-31]	adhesive failure
61						Thick adherend lap shear	Renton, Vinsen [2-31]	adhesive failure
62						Thick adherend lap shear	Renton, Vinsen [2-31]	primarily adhesive failure
63						Thick adherend lap shear	Renton, Vinsen [2-31]	primarily adhesive failure
64						Thick adherend lap shear	Renton, Vinsen [2-31]	primarily adhesive failure
65						Thick adherend lap shear	Renton, Vinsen [2-31]	cohesive failure
66						Thick adherend lap shear	Renton, Vinsen [2-31]	cohesive failure
67						Thick adherend lap shear	Renton, Vinsen [2-31]	cohesive failure
68						Thick adherend lap shear	Renton, Vinsen [2-31]	resin of GI/EP adher. failed
69						Thick adherend lap shear	Renton, Vinsen [2-31]	resin of GI/EP adher. failed
70						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
71						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
72						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
73						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
74						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
75						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
76						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
77						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
78						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
79						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk
80						Thick adherend lap shear	Renton, Vinsen [2-31]	Moduli should not dep. on adh. thk

## Bulk-Adj

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
81	EA 951 Film	0.0031	RM		12.92	0.435	4.50							
82	EA 951 Film	0.0028	RM		11.47	0.434	4.00							
83	EA 951 Film	0.0034	RM		14.28	0.428	5.00							
84	EA 951 Film	0.0035	RM		14.57	0.425	5.13							
85	EA 951 Film	0.0111	RM		17.32	0.468	5.90							
86	EA 951 Film	0.0108	RM		17.36	0.471	5.90							
87	EA 951 Film	0.0111	RM		17.36	0.471	5.90							
88	EA 951 Film	0.0111	RM		17.45	0.479	5.90							
89	EA 951 Film	0.011	RM		17.37	0.472	5.90							

O	P	Q	R	S	T	U	V	W
81						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
82						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
83						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
84						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
85						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
86						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
87						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
88						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.
89						Thick adherend lap shear	Renton, Vinson [2-31]	Moduli should not dep. on adh. thk.

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**Appendix B-2. Lap shear strength of adhesives and  
composites/metals.**

## Adhesive Lays

A	B	C	D	E	F	G
Type of Adhesive	Adhesive Thickness	Overlap Length in inches	Adherend Materials	Surface Preparation	Adherend Layup	Adherend Width in inches
3 AF-126-2 Film	0.0010	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.000
4 AF-126-2 Film	0.0005	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.003
5 AF-126-2 Film	0.0015	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.001
6 AF-126-2 Film	0.0010	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.001
7 AF-126-2 Film	0.0030	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]s	0.999
8 AF-126-2 Film	0.0035	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]s	1.000
9 AF-126-2 Film	0.0025	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]s	0.998
10 AF-126-2 Film	0.0030	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]s	0.998
11 AF-126-2 Film	0.0015	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[0]3, [0]6	1.015
12 AF-126-2 Film	0.0025	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[0]3, [0]6	1.015
13 AF-126-2 Film	0.0028	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[0]3, [0]6	1.015
14 AF-126-2 Film	0.0023	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[0]3, [0]6	1.015
15 AF-126-2 Film	0.0020	2 x 0.218	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.013
16 AF-126-2 Film	0.0020	2 x 0.218	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.014
17 AF-126-2 Film	0.0015	2 x 0.218	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.014
18 AF-126-2 Film	0.0018	2 x 0.218	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.014
19 AF-126-2 Film	0.0025	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)]s	1.014
20 AF-126-2 Film	0.0035	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)]s	1.013
21 AF-126-2 Film	0.0040	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)]s	1.015
22 AF-126-2 Film	0.0033	2 x 0.25	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)]s	1.014
23 AF-126-2 Film	0.0015	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.010
24 AF-126-2 Film	0.0040	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.009
25 AF-126-2 Film	0.0010	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.008
26 AF-126-2 Film	0.0022	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.009
27 AF-126-2 Film	0.0050	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]s	1.008
28 AF-126-2 Film	0.0015	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]s	1.010
29 AF-126-2 Film	0.0015	0.218	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]s	1.010
30 AF-126-2 Film	0.0027	0.239	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]s	1.009
31 AF-126-2 Film	0.0010	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.017
32 AF-126-2 Film	0.0005	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.016
33 AF-126-2 Film	0.0010	2 x 0.218	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.015
34 AF-126-2 Film	0.0008	2 x 0.239	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0]6	1.016
35 AF-126-2 Film	0.0005	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.019
36 AF-126-2 Film	0.0000	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.018
37 AF-126-2 Film	0.0002	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/60)8/0]	1.017
38 AF-126-2 Film	0.0002	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.018
39 AF-126-2 Film	0.0015	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(045/0/-45/0)]s	1.002
40 AF-126-2 Film	0.0005	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(045/0/-45/0)]s	1.020
41 AF-126-2 Film	0.0010	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(045/0/-45/0)]s	1.021
42 AF-126-2 Film	0.0010	2 x 0.25	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(045/0/-45/0)]s	1.014
43 MB-329	0.0140	2.013	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2x[(0/±45/0)]s	1.017
44 MB-329	0.0160	2.024	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2x[(0/±45/0)]s	3.996
45 MB-329	0.0170	2.150	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2x[(0/±45/0)]s	1.003
46 MB-329	0.0170	2.016	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2x[(0/±45/0)]s	1.006
47 MB-329	0.0160	2.051	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2x[(0/±45/0)]s	1.006
48 MB-329	0.0070	0.269	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/60)2/0]4, [(0/45/0)]s	1.003
49 MB-329	0.0070	0.284	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/90)2/0]4, [(0/45/0)]s	1.004
50 MB-329	0.0070	0.247	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/90)2/0]4, [(0/45/0)]s	1.002
51 MB-329	0.0070	0.287	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/90)2/0]4, [(0/45/0)]s	1.003
52 MB-329	0.0010	2.008	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2 x [0]8	0.997
53 MB-329	0.0030	2.005	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2 x [0]8	0.996
54 MB-329	0.0010	2.005	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2 x [0]8	0.997
55 MB-329	0.0017	2.006	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	2 x [0]8	0.997
56 AF-126-2 Film	0.0030	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.016
57 AF-126-2 Film	0.0050	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.015
58 AF-126-2 Film	0.0050	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.015
59 AF-126-2 Film	0.0043	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.015
60 AF-126-2	0.0065	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)]s	1.013
61 AF-126-2	0.0040	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)]s	1.015
62 AF-126-2	0.0075	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)]s	1.015
63 AF-126-2	0.0080	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)]s	1.014
64 AF-126-2	0.0050	2 x 0.5	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.010
65 AF-126-2	0.0050	2 x 0.5	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.011

## Adhesive Lap-J

H	I	J	K	L	M	N	O	P
1 Adherend	Joint	Length	Failure Load Bal Tab/in width	Adhesive Strength, psi	Gross Strength, psi	Failure Mode	Reference	Remarks
2 Thick., in	Type							
3 0.046	Single	4.1250	1120	4480	24.35	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
4 0.046	Single	4.1875	1100	4382	23.91	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
5 0.046	Single	4.1250	970	3880	21.08	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
6 0.046	Single	4.1250	1063	4247	23.11	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Averaged
7 0.047	Single	4.1250	1105	4420	23.51	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
8 0.047	Single	4.1250	1170	4680	24.89	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
9 0.047	Single	4.1250	1165	4679	24.79	Co, Ad-Bo	Grimes...[2-69]	Ep: N5505
10 0.047	Single	4.1250	1147	4593	24.40	Co, Ad-Bo	Grimes...[2-69]	Averaged
11 0.028	Double	4.2500	1785	3514	63.75	Co, Ad-Bo	Grimes...[2-69]	Ep: N5505
12 0.027	Double	4.2500	1740	3425	64.44	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
13 0.027	Double	4.2500	1825	3592	67.59	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
14 0.027	Double	4.2500	1783	3510	66.04	Co, Ad-Bo	Grimes...[2-69]	Averaged
15 0.088	Double	4.1875	1595	3608	18.13	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
16 0.088	Double	4.1875	1430	3235	18.25	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
17 0.087	Double	4.1250	1535	3473	17.84	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
18 0.088	Double	4.1250	1520	3439	17.27	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Averaged
19 0.089	Double	4.2500	2410	4744	27.08	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	(045/0-45)-(045/0-45/45/0-45/0)
20 0.088	Double	4.2500	2225	4397	25.28	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	0' - Half a 0° ply
21 0.087	Double	4.2500	2250	4429	25.86	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
22 0.088	Double	4.2500	2295	4523	26.08	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Averaged
23 0.031, 0.032	Single	2.2500	1000	3968	32.26	Co, Sur. Re, Ad-Ti	Grimes...[2-69]	Ep: N5505
24 0.031, 0.032	Single	2.2500	820	3254	28.45	Co, Sur. Re, Ad-Ti	Grimes...[2-69]	Ep: N5505
25 0.031, 0.032	Single	2.2500	1165	4623	37.58	Co, Ad-Ti, Sur. Re, Ad-Bo	Grimes...[2-69]	Ep: N5505
26 0.031, 0.032	Single	2.2500	995	3948	32.10	Co, Sur. Re, Ad-Ti	Grimes...[2-69]	Averaged
27 0.045, 0.045	Single	2.3750	1215	4821	27.00	Ad-Bo, Ad-Ti, Co	Grimes...[2-69]	Ep: N5505
28 0.045, 0.045	Single	2.3750	1140	4524	25.33	Ad-Bo, Co, Ad-Ti	Grimes...[2-69]	Ep: N5505
29 0.045, 0.045	Single	2.3750	1045	4147	23.22	Co, Ad-Bo, Sur. Res	Grimes...[2-69]	Ep: N5505
30 0.045, 0.045	Single	2.3750	1133	4497	25.18	Ad-Bo, Co, Ad-Ti	Grimes...[2-69]	Averaged
31 0.029, 2x.016	Double	2.3125	2685	5281	92.59	Co, Sur. Re, Ad-Ti, Ad-Bo	Grimes...[2-69]	Ep: N5505
32 0.029, 2x.016	Double	2.3125	2620	5157	90.34	Co, Sur. Re, Ad-Ti, Ad-Bo	Grimes...[2-69]	Ep: N5505
33 0.029, 2x.016	Double	2.3125	2470	5581	85.17	Co, Ad-Ti, Ad-Bo, Sur. Re	Grimes...[2-69]	Ep: N5505
34 0.029, 2x.016	Double	2.25	2592	5373	89.38	Co, Ad-Ti, Sur. Re, Ad-Bo	Grimes...[2-69]	Averaged
35 0.088, 2x.045	Double	2.25	1350	2650	15.34	Co, Ad-Bo, Sur. Re, Ad-Ti	Grimes...[2-69]	Ep: N5505
36 0.089, 2x.045	Double	2.25	2055	4037	23.35	Co, Ad-Ti, Sur. Re, Ad-Bo	Grimes...[2-69]	Ep: N5505
37 0.087, 2x.045	Double	2.25	2215	4356	25.17	Co, Ad-Ti, Sur. Re, Ad-Bo	Grimes...[2-69]	Ep: N5505
38 0.088, 2x.045	Double	2.25	1873	3881	21.28	Co, Ad-Bo, Ad-Ti, Sur. Re	Grimes...[2-69]	Averaged
39 0.087, 2x.045	Double	2.25	2260	4511	25.68	Ad-Ti, Co, Sur. Re, Ad-Bo	Grimes...[2-69]	(045/0-45)-(045/0-45/45/0-45/0)
40 0.088, 2x.045	Double	2.25	2360	4627	26.82	Co, Ad-Ti, Sur. Re, Ad-Bo	Grimes...[2-69]	0' - Half a 0° ply
41 0.088, 2x.045	Double	2.25	2485	4888	28.24	Sur. Re, co, Ad-Ti, Ad-Bo, Int.	Grimes...[2-69]	Ep: N5505
42 0.088, 2x.045	Double	2.25	2368	4689	26.91	co, Ad-Ti, Sur. Re, Ad-Bo	Grimes...[2-69]	Averaged
43 0.166, 0.173	1-S.I.L.	6.4375	1700	830	10.24	Sur. Re, Ad-Ti, Co	Grimes...[2-69]	Ep: N5505
44 0.166, 0.178	1-S.I.L.	6.4375	1740	863	10.48	Sur. Re, Ad-Ti, Co	Grimes...[2-69]	Ep: N5505
45 0.166, 0.177	1-S.I.L.	6.4375	1710	793	10.30	Sur. Re, Ad-Ti, Co, Ad-Bo	Grimes...[2-69]	Ep: N5505
46 0.166, 0.177	1-S.I.L.	6.4375	1830	902	11.02	Sur. Re, Ad-Ti, Co, ...	Grimes...[2-69]	Ep: N5505
47 0.166, 0.167	1-S.I.L.	6.4375	1745	847	10.51	Sur. Re, Ad-Ti, Co, ...	Grimes...[2-69]	Averaged
48 0.086, 3-S.I.L-M	4.1875	850	3150	9.88	Co, Sur. Re, Int.	Grimes...[2-69]	Ep: N5505	
49 0.086, 3-S.I.L-M	4.1875	935	3280	10.87	Sur. Re, Co, Int, Ad-Bo	Grimes...[2-69]	Ep: N5505	
50 0.086, 3-S.I.L-M	4.1875	915	3697	10.64	Int, Sur. Re, Co, Ad-Bo	Grimes...[2-69]	Ep: N5505	
51 0.086, 3-S.I.L-M	4.1875	900	3376	10.47	Sur. Re, Co, Int, Ad-Bo	Grimes...[2-69]	Averaged	
52 0.088, 0.087	1-S.I.L.	7.50	2835	1418	32.59	Sur. Re, Ad-Ti, Co	Grimes...[2-69]	Ep: N5505
53 0.086, 0.083	1-S.I.L.	7.50	2205	1104	25.34	Ad-Ti, Sur. Re, Co, Int	Grimes...[2-69]	Ep: N5505
54 0.087, 0.085	1-S.I.L.	7.50	2910	1456	33.45	Sur. Re, Ad-Ti, Int, Co	Grimes...[2-69]	Ep: N5505
55 0.086, 0.085	1-S.I.L.	7.50	2650	1325	30.46	Sur. Re, Ad-Ti, Co, Int.	Grimes...[2-69]	Averaged
56 0.044	Single	5.25	5750	4528	130.68	Sur. Re, Int, Co, Ad-Bo	Grimes...[2-69]	Ep: N5505
57 0.043	Single	5.25	5535	4362	128.72	Sur. Re, Co, Int	Grimes...[2-69]	Ep: N5505
58 0.043	Single	5.25	5720	4508	133.02	Sur. Re, Co, Int	Grimes...[2-69]	Ep: N5505
59 0.043	Single	5.25	5668	4486	131.81	Sur. Re, Co, Int.	Grimes...[2-69]	Averaged
60 0.043	Single	3.2813	4100	3238	95.35	Ad-Bo, Sur. Re, Int	Grimes...[2-69]	0' - Half a 0° ply
61 0.044	Single	3.25	3815	3007	88.70	Ad-Bo, Sur. Re	Grimes...[2-69]	0' - Half a 0° ply
62 0.043	Single	3.25	3900	3074	90.70	Ad-Bo, Sur. Re	Grimes...[2-69]	0' - Half a 0° ply
63 0.043	Single	3.25	3938	3108	91.58	Ad-Bo, Sur. Re	Grimes...[2-69]	Averaged
64 0.031	Double	4.1875	4020	3980	129.68	Ad-Bo, Co, Sur. Re, ...	Grimes...[2-69]	Ep: N5505
65 0.031	Double	4.1875	4085	4040	131.77	Co, Ad-Bo, Sur. Re, ...	Grimes...[2-69]	Ep: N5505

	A	B	C	D	E	F	G
60	AF-123-2	0.0045	2 x 0.5	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3.0[6]	1.013
67	AF-126-2	0.0048	2 x 0.5	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3.0[6]	1.013
68	AF-126-2	0.0035	2 x 0.437	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.015
69	AF-126-2	0.0025	2 x 0.437	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.013
70	AF-126-2	0.0020	2 x 0.437	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.013
71	AF-126-2	0.0027	2 x 0.437	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.014
72	AF-126-2	0.0022	2 x 0.75	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.014
73	AF-126-2	0.0018	2 x 0.75	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.013
74	AF-126-2	0.0020	2 x 0.75	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.015
75	AF-126-2	0.0020	2 x 0.75	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.014
76	AF-126-2	0.0050	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.016
77	AF-126-2	0.0055	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.015
78	AF-126-2	0.0070	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.014
79	AF-126-2	0.0058	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.015
80	AF-126-2	0.0020	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0's]	1.014
81	AF-126-2	0.0020	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0's]	1.013
82	AF-126-2	0.0045	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0's]	1.015
83		0.0028	1.250	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0's]	1.014
84	AF-126-2	0.0005	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.013
85	AF-126-2	0.0000	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.013
86	AF-126-2	0.0002	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.015
87	AF-126-2	0.0003	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.014
88	AF-126-2	0.0020	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.020
89	AF-126-2	0.0020	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.019
90	AF-126-2	0.0018	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.020
91	AF-126-2	0.0019	2 x 0.5	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.020
92	AF-126-2	0.0032	2 x 0.687	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45/0)s]	0.962
93	AF-126-2	0.0032	2 x 0.687	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45/0)s]	1.012
94	AF-125-2	0.0025	2 x 0.687	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45/0)s]	1.004
95	AF-126-2	0.0030	2 x 0.687	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45/0)s]	0.883
96	MB-320	0.0100	2.012	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	2 x [0](90)2/0[4]	1.001
97	MB-320	0.0130	2.009	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	2 x [0](90)2/0[4]	1.002
98	MB-320	0.0150	2.008	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	2 x [0](90)2/0[4]	1.000
99	MB-320	0.0130	2.010	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	2 x [0](90)2/0[4]	1.001
100	AF-126-2	0.0005	3.686	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [0](80)2/0[4]	1.003
101	AF-126-2	0.0010	3.691	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [0](90)2/0[4]	1.002
102	AF-126-2	0.0015	3.689	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [0](90)2/0[4]	1.001
103	AF-126-2	0.0010	3.689	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [0](90)2/0[4]	1.002
104	AF-126-2	0.0055	3.864	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [(0+45/0)q)s]	1.005
105	AF-126-2	0.0070	3.896	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [(0±45/0)q)s]	1.002
106	AF-126-2	0.0050	3.881	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [(0±45/0)q)s]	1.003
107	AF-126-2	0.0055	3.875	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [(0±45/0)q)s]	1.002
108	AF-126-2	0.0058	3.879	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	3 x [(0±45/0)q)s]	1.003
109	AF-126-2	0.0030	1.734	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.016
110	AF-126-2	0.0070	1.723	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.070
111	AF-126-2	0.0030	1.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.051
112	AF-126-2	0.0043	1.736	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0]9	1.046
113	AF-126-2	0.0040	2.000	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)s]	1.002
114	AF-126-2	0.0045	2.000	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)s]	1.006
115	AF-126-2	0.0040	2.000	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)s]	1.010
116	AF-126-2	0.0042	2.000	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45/0)s]	1.006
117	AF-126-2	0.0030	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3.0[6]	1.010
118	AF-126-2	0.0035	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3.0[6]	1.010
119	AF-126-2	0.0035	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3.0[6]	1.013
120	AF-126-2	0.0033	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3.0[6]	1.011
121	AF-126-2	0.0000	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.011
122	AF-126-2	0.0012	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.013
123	AF-126-2	0.0015	2 x 0.687	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.013
124	AF-126-2	0.0009	2 x 0.729	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.012
125	AF-126-2	0.0042	2 x 0.125	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.013
126	AF-126-2	0.0035	2 x 0.125	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.011
127	AF-126-2	0.0034	2 x 0.125	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.013
128	AF-126-2	0.0037	2 x 0.125	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)s, [(045/0/-45/0)s]	1.012
129	AF-126-2	0.0035	1.687	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.000
130	AF-126-2	0.0045	1.687	Bo/Ep-Ti	Ti: Grt blast, Oakite 31, 841ml HCL acid	[0]6	1.001

## Adhesive Lap-J

H	I	J	K	L	M	N	O	P
66	0.032	Double	4.1875	3905	3055	122.03	Ad-Bo, Co, Sur.Re, ...	Grimes...[2-69]
67	0.031	Double	4.1875	4003	3958	129.13	Ad-Bo, Co, Sur.Re, ...	Grimes...[2-69]
68	0.088	Double	4.4063	4900	6524	58.98	Co, Ad-Bo	Grimes...[2-69]
69	0.087	Double	4.4063	4890	5523	58.21	Co, Ad-Bo, Int	Grimes...[2-69]
70	0.087	Double	4.3750	4558	5144	52.36	Ad-Bo, co, ...	Grimes...[2-69]
71	0.087	Double	4.4063	4782	5397	54.97	Co, Ad-Bo, ...	Grimes...[2-69]
72	0.088	Double	4.3750	7160	4707	81.38	Co, Sur.Re, Ad-Bo	Grimes...[2-69]
73	0.088	Double	4.6250	7185	4728	81.68	Co, Sur.Re, Ad-Bo	Grimes...[2-69]
74	0.088	Double	4.6250	6710	4407	78.25	Co, Ad-Bo, Sur.Re	Grimes...[2-69]
75	0.088	Double	4.5313	7018	4614	79.75	Co, Sur.Re, Ad-Bo	Grimes...[2-69]
76	0.031, 0.032	Single	3.1875	4280	3370	138.06	Ad-Ti, Co, Sur.Re, Int	Grimes...[2-69]
77	0.031, 0.032	Single	3.1875	4195	3308	135.32	Sur.Re, Int, Ad-Ti, Co	Grimes...[2-69]
78	0.031, 0.032	Single	3.1875	4115	3246	132.74		Grimes...[2-69]
79	0.031, 0.032	Single	3.1875	4197	3307	135.39	Co, Ad-Ti, Sur.Re, Int	Grimes...[2-69]
80	0.047, 0.045	Single	3.25	4400	3471	93.82		Grimes...[2-69]
81	0.047, 0.045	Single	3.25	4010	3167	85.32	Sur.Re, Int, Co	Grimes...[2-69]
82	0.047, 0.045	Single	3.25	4355	3432	92.66		Grimes...[2-69]
83	0.047, 0.045	Single	3.25	4255	3357	90.53	Sur.Re, Int, ...	Grimes...[2-69]
84	0.030, 2x.018	Double	2.50	- 3990	3939	133.00	Co, Sur.Re, Ad-Bo, Ad-Ti	Grimes...[2-69]
85	0.030, 2x.018	Double	2.50	4010	3958	133.67	Other	Grimes...[2-69]
86	0.030, 2x.018	Double	2.50	3840	3783	128.00	Other	Grimes...[2-69]
87	0.030, 2x.018	Double	2.50	3947	3893	131.57	Other, Co, Sur.Re	Grimes...[2-69]
88	0.085, 2x.045	Double	2.50	5250	5147	61.76	Int, Sur.Re, Co, Ad-Ti	Grimes...[2-69]
89	0.085, 2x.045	Double	2.50	5200	5103	61.18	Other	Grimes...[2-69]
90	0.085, 2x.045	Double	2.50	5210	5108	61.29	Co, Sur.Re, Ad-Ti, Int	Grimes...[2-69]
91	0.085, 2x.045	Double	2.50	5220	5119	61.41	Co, Sur.Re, Int, Ad-Ti	Grimes...[2-69]
92	0.087, 2x.045	Double	2.6875	7550	5685	86.78	Sur.Re, Co, Int, Ad-Ti	Grimes...[2-69]
93	0.087, 2x.045	Double	2.6875	7570	5444	87.01	Int, Co, Sur.Re, Ad-Ti	Grimes...[2-69]
94	0.087, 2x.045	Double	2.6875	7230	5241	83.10	Sur.Re, Co, Int, Ad-Ti	Grimes...[2-69]
95	0.087, 2x.045	Double	2.6875	7450	5457	85.63	Sur.Re, Int, Co, Ad-Ti	Grimes...[2-69]
96	0.175, 0.180	1-S.I.L.	5.875	1590	789	9.09	..Ad-Ti, Sur.Re	Grimes...[2-69]
97	0.172, 0.178	1-S.I.L.	5.875	1405	698	8.17	Ad-Ti, Sur.Re, ..	Grimes...[2-69]
98	0.171, 0.174	1-S.I.L.	5.875	1480	737	8.65	Ad-Ti, Sur.Re, Ad-Bo, ..	Grimes...[2-69]
99	0.1727, 0.1767	1-S.I.L.	5.875	1492	741	8.62	Ad-Ti, Sur.Re, ...	Grimes...[2-69]
100	0.2637, 0.265	2-S.I.L.	4.875	5845	1581	22.17	Other	Grimes...[2-69]
101	0.2637, 0.265	2-S.I.L.	4.875	5690	1538	21.58	Other	Grimes...[2-69]
102	0.2637, 0.265	2-S.I.L.	4.875	4675	1266	17.73	Other	Grimes...[2-69]
103	0.2637, 0.265	2-S.I.L.	4.875	5403	1462	20.49	Other	Grimes...[2-69]
104	0.260, 0.264	2-S.I.L.	5.6875	9660	2488	37.15	Sur.Re, Int, Ad-Bo	Grimes...[2-69]
105	0.260, 0.264	2-S.I.L.	5.6875	11850	3038	45.58	Int, Sur.Re, ...	Grimes...[2-69]
106	0.268, 0.264	2-S.I.L.	5.6875	12100	3108	45.15	Int, Sur.Re, ...	Grimes...[2-69]
107	0.260, 0.264	2-S.I.L.	5.6875	10975	2826	42.21	Int, Ad-Bo, Co, Sur.Re	Grimes...[2-69]
108	0.262, 0.264	2-S.I.L.	5.6875	11146	2884	42.54	Int, Sur.Re, Ad-Bo, ...	Grimes...[2-69]
109	0.048	Single	7.625	7800	4383	165.22	Other	Grimes...[2-69]
110	0.048	Single	7.625	8430	4572	183.26	Int, Co, Sur.Re	Grimes...[2-69]
111	0.046	Single	7.625	7590	4127	165.00	Other	Grimes...[2-69]
112	0.046	Single	7.625	7873	4361	171.15	Int, Co, Sur.Re, ...	Grimes...[2-69]
113	0.046	Single	6.875	4715	2353	102.50	Other	Grimes...[2-69]
114	0.048	Single	6.875	4750	2381	103.26	Other	Grimes...[2-69]
115	0.046	Single	6.875	4810	2381	104.57	Other	Grimes...[2-69]
116	0.048	Single	6.875	4758	2368	103.43	Other	Grimes...[2-69]
117	0.032	Double	4.625	4070	2688	127.19	Other	Grimes...[2-69]
118	0.031	Double	4.625	4060	2680	130.97	Other	Grimes...[2-69]
119	0.031	Double	4.625	4320	2643	139.35	Other	Grimes...[2-69]
120	0.031	Double	4.625	4150	2738	133.87	Other	Grimes...[2-69]
121	0.087	Double	4.6250	6200	4088	71.28		Grimes...[2-69]
122	0.087	Double	4.6250	5750	3784	66.09		Grimes...[2-69]
123	0.087	Double	4.6250	5745	3127	66.03		Grimes...[2-69]
124	0.087	Double	4.6250	5898	4000	67.79		Grimes...[2-69]
125	0.089	Double	5.1875	8890	3510	99.89		Grimes...[2-69]
126	0.09	Double	5.1875	7695	3044	85.50		Grimes...[2-69]
127	0.089	Double	5.1875	9560	3774	107.42		Grimes...[2-69]
128	0.09	Double	5.1875	8715	3443	96.83		Grimes...[2-69]
129	0.032, 0.032	Single	3.6250	4170	2472	130.31		Grimes...[2-69]
130	0.031, 0.032	Single	3.6250	4170	2489	134.52		Grimes...[2-69]

	A	B	C	D	E	F	G
131	AF-126-2	0.0045	1.687	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.000
132	AF-126-2	0.0042	1.687	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.000
133	AF-126-2	0.0035	2.000	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.005
134	AF-126-2	0.0025	2.000	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.005
135	AF-126-2	0.0035	2.000	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.004
136	AF-126-2	0.0032	2.000	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.005
137	AF-126-2	0.0005	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.007
138	AF-126-2	0.0000	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.006
139	AF-126-2	0.0000	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.005
140	AF-126-2	0.0002	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.006
141	AF-126-2	0.0005	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.007
142	AF-126-2	0.0012	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.007
143	AF-126-2	0.0010	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.006
144	AF-126-2	0.0009	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.007
145	AF-126-2	0.0015	2 x 0.125	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		1.007
146	AF-126-2	0.0020	2 x 0.125	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		1.007
147	AF-126-2	0.0018	2 x 0.125	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		1.008
148	AF-126-2	0.0018	2 x 0.125	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		1.007
149	AF-126-2	0.0053	2.062	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid 4 x [90]9		1.003
150	AF-126-2	0.0063	1.998	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid 4 x [90]9		1.003
151	AF-126-2	0.0060	1.848	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid 4 x [90]9		1.001
152	AF-126-2	0.0009	1.989	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid 4 x [90]9		1.002
153	MB-329	0.0050	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.019
154	MB-329	0.0040	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.019
155	MB-329	0.0040	0.250	Bo/E-Bo-Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.020
156	MB-329	0.0043	0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.019
157	MB-329	0.0065	0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45)q/0']s	1.003
158	MB-329	0.0080	0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45)q/0']s	1.002
159	MB-329	0.0065	0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45)q/0']s	1.003
160	MB-329	0.0070	0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[(0/45/0/-45)q/C']s	1.003
161	MB-329	0.0025	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]8	1.015
162	MB-329	0.0038	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.015
163	MB-329	0.0038	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.015
164	MB-329	0.0034	2 x 0.250	Bo/Ep-Pu/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.015
165	MB-329	0.0100	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.015
166	MB-329	0.0065	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.016
167	MB-329	0.0062	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.016
168	MB-329	0.0078	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.016
169	MB-329	0.0090	2 x 0.187	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/45/0/-45)q/0'], [(0/45/0/-45)q/0']s	1.015
170	MB-329	0.0090	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/45/0/-45)q/0'], [(0/45/0/-45)q/0']s	1.015
171	MB-329	0.0080	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/45/0/-45)q/0'], [(0/45/0/-45)q/0']s	1.015
172	MB-329	0.0087	2 x 0.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/45/0/-45)q/0'], [(0/45/0/-45)q/0']s	1.015
173	MB-329	0.0045	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.011
174	MB-329	0.0060	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.009
175	MB-329	0.0045	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.010
176	MB-329	0.0050	0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.010
177	MB-329	0.0045	0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.008
178	AF-126-2	0.0050	0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.009
179	AF-126-2	0.0040	0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.009
180	AF-126-2	0.0045	0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45/0')]s		1.009
181	AF-126-2	0.0068	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.015
182	AF-126-2	0.0055	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.016
183	AF-126-2	0.0055	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.014
184	AF-126-2	0.0059	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [0] 6		1.015
185	AF-126-2	0.0055	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.017
186	AF-126-2	0.0052	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.014
187	AF-126-2	0.0055	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.021
188	AF-126-2	0.0054	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/90)8/0]		1.017
189	AF-126-2	0.0087	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		1.017
190	MB-329	0.0080	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		0.961
191	MB-329	0.0072	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		1.000
192	MB-329	0.0080	2 x 0.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid [(0/45/0/-45)q/0']s		0.993
193	MB-329	0.0045	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.013
194	MB-329	0.0090	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.015
195	MB-329	0.0085	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.013

## Adhesive Lap-J

	H	I	J	K	L	M	N	O	P
131	0.011, 0.032	Single	3.6250	4165	2469	134.35		Grimes...[2-69]	
132	0.011, 0.032	Single	3.6250	4168	2470	134.45		Grimes...[2-69]	Averaged
133	0.016, 0.045	Single	3.8750	5245	209	114.02		Grimes...[2-69]	0' = Half a 0° ply
134	0.017, 0.045	Single	3.8750	5075	2525	107.98		Grimes...[2-69]	
135	0.016, 0.045	Single	3.8750	4940	2460	107.39		Grimes...[2-69]	
136	0.017, 0.045	Single	3.8750	5087	2531	108.23		Grimes...[2-69]	Averaged
137	0.010, 2x0.016	Double	2.6250	3340	2211	111.33		Grimes...[2-69]	
138	0.010, 2x0.016	Double	2.6250	3360	2227	112.00		Grimes...[2-69]	
139	0.030, 2x0.016	Double	2.6250	3360	2229	112.00		Grimes...[2-69]	
140	0.030, 2x0.016	Double	2.6250	3353	2222	111.77		Grimes...[2-69]	Averaged
141	0.085, 2x0.045	Double	2.6875	6180	4091	72.71		Grimes...[2-69]	
142	0.084, 2x0.045	Double	2.6875	5675	3757	66.76		Grimes...[2-69]	
143	0.085, 2x0.045	Double	2.6875	5935	3933	69.82		Grimes...[2-69]	
144	0.085, 2x0.045	Double	2.6875	5930	3927	69.76		Grimes...[2-69]	Averaged
145	0.089, 2x0.045	Double	3.1250	10250	4071	115.17		Grimes...[2-69]	(045/0/-45) - (045/0/-45/MSD/45/0)
146	0.089, 2x0.045	Double	3.3330	9280	3686	104.27		Grimes...[2-69]	0' = Half a 0° ply
147	0.089, 2x0.045	Double	3.1250	9810	3833	110.22		Grimes...[2-69]	
148	0.089, 2x0.045	Double	3.1250	9780	3883	109.89		Grimes...[2-69]	Averaged
149	0.162, 0.176	3-St.L.	6.4375	12150	5875	148.17	Sur.Re,Ad-Ti,Co,Ad-Bo	Grimes...[2-69]	
150	0.178, 0.173	3-St.L.	6.4375	12450	8212	159.62	Sur.Re,Ad-Ti,Ad-Bo,Co	Grimes...[2-69]	
151	0.179, 0.174	3-St.L.	6.4375	10750	5811	136.08	Sur.Re,Co,Ad-Ti,Ad-Bo	Grimes...[2-69]	
152	0.1797, 0.1743	3-St.L.	6.4375	11783	5966	149.15	Sur.Re,Ad-Ti,Co,Ad-Bo	Grimes...[2-69]	Averaged
153	0.04	Single	4.3125	1075	4219	26.88	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	
154	0.041	Single	4.3125	1140	4474	27.80	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	
155	0.041	Single	4.3125	1010	3961	24.63	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	
156	0.04	Single	4.3125	1075	4218	26.88	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	Averaged
157	0.043	Single	4.5625	855	1705	19.88	Ad-Bo,C0, Sur.Re	Grimes...[2-69]	0' = Half a 0° ply
158	0.043	Single	4.5625	870	1736	20.23	Ad-Bo,C0, Sur.Re	Grimes...[2-69]	
159	0.044	Single	4.5625	915	1824	20.80	Ad-Bo,C0, Sur.Re	Grimes...[2-69]	
160	0.043	Single	4.5625	880	1755	20.47	Ad-Bo,C0, Sur.Re	Grimes...[2-69]	Averaged
161	0.032	Double	4.25	1910	3764	59.69	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	
162	0.032	Double	4.25	2265	4463	70.78	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	
163	0.032	Double	4.25	2320	4571	72.50	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	
164	0.032	Double	4.25	2165	4266	67.66	Sur.Re,Co,Ad-Bo	Grimes...[2-69]	Averaged
165	0.090	Double	4.25	1715	3379	19.06	Sur.Re, Co, Ad-Bo	Grimes...[2-69]	
166	0.090	Double	4.25	1800	3543	20.00	Sur.Re, Co, Ad-Bo	Grimes...[2-69]	
167	0.090	Double	4.25	1640	3228	18.22	Co, Sur.Re, Ad-Bo	Grimes...[2-69]	
168	0.090	Double	4.25	1718	3383	19.09	Sur.Re, Co, Ad-Bo	Grimes...[2-69]	Averaged
169	0.08	Double	4.25	2090	5506	23.22	Ad-Bo, Sur.Re, Co	Grimes...[2-69]	(045/0/-45) - (045/0/-45/MSD/45/0)
170	0.092	Double	4.3125	1770	3488	19.24	Ad-Bo, Sur.Re, Co	Grimes...[2-69]	0' = Half a 0° ply
171	0.091	Double	4.3125	2170	4276	23.85	Ad-Bo, Sur.Re, Co	Grimes...[2-69]	
172	0.091	Double	4.3125	2010	4423	22.09	Ad-Bo, Sur.Re, Co	Grimes...[2-69]	Averaged
173	0.031, 0.032	Single	4.3125	810	3204	27.00	Sur.Re, Int, Ad-Bo	Grimes...[2-69]	
174	0.019, 0.032	Single	2.3125	740	2934	24.67	Sur.Re, Int, Ad-Bo	Grimes...[2-69]	
175	0.010, 0.032	Single	2.3125	780	3089	26.00	Sur.Re, Int, Ad-Bo	Grimes...[2-69]	
176	0.010, 0.032	Single	2.3125	777	3076	25.90	Sur.Re, Int, Ad-Bo	Grimes...[2-69]	Averaged
177	0.043, 0.045	Single	2.3125	1020	2024	23.72	Sur.Re, Ad-Bo, Co,Int	Grimes...[2-69]	0' = Half a 0° ply
178	0.043, 0.045	Single	3.0313	980	1942	22.79	Ad-Bo, Sur.Re, Co	Grimes...[2-69]	
179	0.043, 0.045	Single	3.0625	920	1824	21.40	Ad-Bo, Sur.Re, Co	Grimes...[2-69]	
180	0.043, 0.045	Single	3.0625	973	1930	22.63	Ad-Bo, Sur.Re, Co	Grimes...[2-69]	Averaged
181	0.010, 0.016	Double	3.0625	2735	5389	91.17	Sur.Re, Co, Int	Grimes...[2-69]	
182	0.010, 0.016	Double	2.25	2430	4783	81.00	Sur.Re, Ad-Bo, Ad-Ti, Co	Grimes...[2-69]	
183	0.010, 0.016	Double	2.25	2770	5461	92.33	Sur.Re, Ad-Bo, Ad-Ti, Co	Grimes...[2-69]	
184	0.010, 0.016	Double	2.25	2645	5212	88.17	Sur.Re, Ad-Bo, Ad-Ti, Co	Grimes...[2-69]	Averaged
185	0.087, 0.045	Double	2.25	2345	4612	27.27	Sur.Re, Ad-Bo, Co, Int	Grimes...[2-69]	
186	0.086, 0.045	Double	2.25	2410	4753	28.02	Sur.Re, Int	Grimes...[2-69]	
187	0.085, 0.045	Double	2.25	2770	5476	32.21	Sur.Re, Int, Co	Grimes...[2-69]	
188	0.086, 0.045	Double	2.25	2508	4930	29.16	Sur.Re, Int, Ad-Bo	Grimes...[2-69]	Averaged
189	0.089, 0.045	Double	2.3125	1025	2016	11.52	Sur.Re, Ad-Ti, Co	Grimes...[2-69]	(045/0/-45) - (045/0/-45/MSD/45/0)
190	0.010, 0.045	Double	2.3125	1865	3881	20.98	Sur.Re, Ad-Ti, Co	Grimes...[2-69]	0' = Half a 0° ply
191	0.019, 0.045	Double	2.375	1870	3740	21.01	Sur.Re, Ad-Ti, Co	Grimes...[2-69]	
192	0.089, 0.045	Double	2.3125	1567	3212	17.83	Sur.Re, Ad-Ti, Co	Grimes...[2-69]	Averaged
193	0.041	Single	5.3125	3230	2551	78.78	Sur.Re, Co, Int	Grimes...[2-69]	
194	0.040	Single	5.3125	3100	2443	77.50	Ad-Bo, Int, Co	Grimes...[2-69]	
195	0.040	Single	5.3125	2805	2215	70.13	Sur.Re, Co, Int	Grimes...[2-69]	

	A	B	C	D	E	F	G
196	MB-329	0.0073	1.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.014
197	MB-329	0.0110	1.500	Bo/Ep-Bo/Ep	Bo: ANEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.012
198	MB-329	0.0120	1.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.014
199	MB-329	0.0120	1.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.015
200	MB-329	0.0117	1.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.013
201	MB-329	0.0052	2 x 0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.013
202	MB-329	0.0052	2 x 0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.013
203	MB-329	0.0060	2 x 0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.011
204	MB-329	0.0050	2 x 0.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.012
205	MB-329	0.0048	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.012
206	MB-329	0.0045	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.012
207	MB-329	0.0045	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.015
208	MB-329	0.0046	2 x 0.750	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.013
209	MB-329	0.0085	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(045/0/-45)q/0]'s	1.013
210	MB-329	0.0065	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45)q/0]'s, [(045/0/-45)q/0]'s	1.013
211	MB-329	0.0092	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45)q/0]'s, [(045/0/-45)q/0]'s	1.014
212	MB-329	0.0081	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45)q/0]'s, [(045/0/-45)q/0]'s	1.013
213	MB-329	0.0050	1.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.009
214	MB-329	0.0055	1.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.012
215	MB-329	0.0050	1.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.012
216	MB-329	0.0052	1.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.011
217	MB-329	0.0040	1.437	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.013
218	MB-329	0.0040	1.437	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.012
219	MB-329	0.0030	1.437	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.014
220	MB-329	0.0037	1.437	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.013
221	MB-329	0.0040	2 x 0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.003
222	MB-329	0.0060	2 x 0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.003
223	MB-329	0.0060	2 x 0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.003
224	MB-329	0.0053	2 x 0.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.003
225	MB-329	0.0060	2 x 0.687	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.002
226	MB-329	0.0072	2 x 0.687	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.005
227	MB-329	0.0068	2 x 0.750	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.002
228	MB-329	0.0067	2 x 0.708	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/90)8/0]	1.003
229	MB-329	0.0088	2 x 0.100	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45)q/0]'s	1.006
230	MB-329	0.0100	2 x 0.100	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45)q/0]'s	1.006
231	MB-329	0.0108	2 x 0.100	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45)q/0]'s	1.004
232	MB-329	0.0099	2 x 0.100	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[(0/45/0/-45)q/0]'s	1.005
233	MB-329	0.0070	2.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.008
234	MB-329	0.0070	2.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.010
235	MB-329	0.0055	2.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.007
236	MB-329	0.0063	2.250	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0] 8	1.008
237	MB-329	0.0090	2.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.008
238	MB-329	0.0080	2.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.010
239	MB-329	0.0090	2.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.003
240	MB-329	0.0087	2.500	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	[0/45/0/-45/0]'s	1.007
241	MB-329	0.0090	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.013
242	MB-329	0.0082	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.013
243	MB-329	0.0075	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.011
244	MB-329	0.0082	2 x 0.100	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2 x [0]3,[0]6	1.012
245	MB-329	0.0062	2 x 0.150	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.011
246	MB-329	0.0072	2 x 0.150	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.010
247	MB-329	0.0072	2 x 0.150	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.014
248	MB-329	0.0069	2 x 0.150	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(0/90)4/0], [(0/90)8/0]	1.012
249	MB-329	0.0068	2 x 0.175	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)'s, [(045/0/-45)q/0]'s]	1.007
250	MB-329	0.0058	2 x 0.175	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)'s, [(045/0/-45)q/0]'s]	1.010
251	MB-329	0.0070	2 x 0.175	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)'s, [(045/0/-45)q/0]'s]	1.011
252	MB-329	0.0065	2 x 0.175	Bo/Ep-Bo/Ep	Bo: MEK, sandpaper<#400, MEK	2x[(045/0/-45/0)'s, [(045/0/-45)q/0]'s]	1.009
253	MB-329	0.0045	2.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 8	0.999
254	MB-329	0.0050	2.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.000
255	MB-329	0.0050	2.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.000
256	MB-329	0.0048	2.250	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0] 6	1.000
257	MB-329	0.0095	2.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.000
258	MB-329	0.0110	2.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.004
259	MB-329	0.0115	2.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.007
260	MB-329	0.0107	2.500	Bo/Ep-Ti	Ti: Grit blast, Oakite 31, 841ml HCL acid	[0/45/0/-45/0]'s	1.004

	H	I	J	K	L	M	N	O	P
196	0.041	Single	5.3125	3045	2403	74.27	Sur. Re, Co, Int	Grimes...[2-69]	Averaged
197	0.044	Single	5.5625	2135	1406	48.52	Ad-Bo, Co, Sur. Re	Grimes...[2-69]	0' - Half a 0° ply
198	0.044	Single	5.625	2145	1410	48.75	Ad-Bo, Co, Sur. Re	Grimes...[2-69]	
199	0.044	Single	5.625	2190	1438	49.77	Ad-Bo, Sur. Re	Grimes...[2-69]	
200	0.044	Single	5.625	2157	1418	49.02	Ad-Bo, Co, Sur. Re	Grimes...[2-69]	Averaged
201	0.031	Double	4.375	3840	3751	123.87	Ad-Bo, Sur. Re, Co	Grimes...[2-69]	
202	0.031	Double	4.375	4845	4585	149.84	Ad-Bo, Sur. Re, Co	Grimes...[2-69]	
203	0.032	Double	4.375	4415	4367	137.97		Grimes...[2-69]	
204	0.031	Double	4.375	4300	4248	138.71	Ad-Bo, Sur. Re, Co	Grimes...[2-69]	Averaged
205	0.088	Double	4.50	4950	3261	58.25	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	
206	0.088	Double	4.50	4945	3258	56.19	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	
207	0.088	Double	4.50	5250	3448	59.66	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	
208	0.088	Double	4.50	5048	3322	57.36	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	Averaged
209	0.087	Double	4.875	4750	2344	54.60	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	
210	0.085	Double	4.875	5510	2720	64.82	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	
211	0.085	Double	4.875	5510	2717	64.82	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	
212	0.086	Double	4.875	5257	2594	61.13	Sur. Re, Ad-Bo, Co	Grimes...[2-69]	Averaged
213	0.032, 0.032	Single	5.1875	1905	1510	59.53	Ad-Ti,Sur.Re,Co,Ad-Bo,Int	Grimes...[2-69]	
214	0.031, 0.032	Single	5.1875	1915	1514	59.84	Sur.Re,Ad-Ti,Co,Ad-Bo	Grimes...[2-69]	
215	0.032, 0.032	Single	5.1875	2050	1620	64.06	Sur.Re,Ad-Ti,Co,Ad-Bo	Grimes...[2-69]	
216	0.032, 0.032	Single	5.1875	1957	1548	61.16	Sur.Re,Ad-Ti,Co,Ad-Bo	Grimes...[2-69]	Averaged
217	0.043, 0.045	Single	5.4375	1960	1346	45.58	Sur. Re, Int, Co	Grimes...[2-69]	
218	0.043, 0.045	Single	5.4375	2070	1423	48.14	Sur.Re,Int,Co,Ad-Bo,Ad-Ti	Grimes...[2-69]	
219	0.043, 0.045	Single	5.4375	2250	1544	52.33	Sur.Re,Int,Co,Ad-Bo,Ad-Ti	Grimes...[2-69]	
220	0.043, 0.045	Single	5.4375	2093	1438	48.67	Sur.Re,Int,Co	Grimes...[2-69]	Averaged
221	0.030, 2x0.016	Double	3.375	1210	1206	39.03	Co, Ad-Ti, Sur. Re	Grimes...[2-69]	
222	0.031, 2x0.016	Double	3.375	1350	1346	43.55	Co, Ad-Ti, Sur. Re	Grimes...[2-69]	
223	0.032, 2x0.016	Double	3.375	1430	1426	46.13	Co, Ad-Ti, Sur. Re	Grimes...[2-69]	
224	0.031, 2x0.016	Double	3.375	1330	1326	42.90	Co, Ad-Ti, Sur. Re	Grimes...[2-69]	Averaged
225	0.080, 2x0.045	Double	2.75	4955	3599	55.06	Int, Sur.Re, Ad-Ti, Co	Grimes...[2-69]	
226	0.088, 2x0.045	Double	2.8125	4515	3270	50.17	Int, Ad-Ti, Sur. Re	Grimes...[2-69]	
227	0.090, 2x0.045	Double	2.8125	4640	3087	51.56	Int,Ad-Ti,Sur.Re,Ad-Bo	Grimes...[2-69]	
228	C.090, 2x0.045	Double	2.8125	4703	3319	52.26	Int,Ad-Ti,Sur.Re,Ad-Bo	Grimes...[2-69]	Averaged
229	0.089, 2x0.045	Double	3.00	5070	2520	56.97	Sur.Re, Ad-Ti, Co, Int	Grimes...[2-69]	
230	0.089, 2x0.045	Double	3.00	5300	2634	59.55	Sur. Re, Ad-Ti, Co	Grimes...[2-69]	
231	0.088, 2x0.045	Double	3.00	5210	2595	58.54	Sur. Re	Grimes...[2-69]	
232	0.089, 2x0.045	Double	3.00	5193	2455	58.35	Sur. Re, Ad-Ti, Co	Grimes...[2-69]	Averaged
233	0.041	Single	6.00	5150	2271	125.61	Sur. Re, Co, Int	Grimes...[2-69]	
234	0.041	Single	6.00	5205	2290	126.95	Sur. Re, Co, Int	Grimes...[2-69]	
235	0.041	Single	6.00	4350	1920	106.10	Sur. Re, Co, Int	Grimes...[2-69]	
236	0.041	Single	6.00	4902	2160	119.56	Sur. Re, Co, Int	Grimes...[2-69]	Averaged
237	0.048	Single	6.375	2760	1825	57.50	Ad-Bo, Sur. Re	Grimes...[2-69]	0' - Half a 0° ply
238	0.047	Single	6.375	3020	1186	64.26	Ad-Bo, Sur. Re, Int	Grimes...[2-69]	
239	0.048	Single	6.375	3350	1336	69.79	Ad-Bo, Sur. Re, Int	Grimes...[2-69]	
240	0.047	Single	6.375	3043	1209	64.74	Ad-Bo, Sur. Re	Grimes...[2-69]	Averaged
241	0.030	Double	4.875	3555	1755	118.50	Sur.Re, Ad-Bo, Co	Grimes...[2-69]	
242	0.030	Double	4.875	4150	2048	138.33	Int	Grimes...[2-69]	
243	0.030	Double	4.875	4330	2141	144.33	Int,Sur.Re, Co, Ad-Bo	Grimes...[2-69]	
244	0.030	Double	4.875	4012	1981	133.73	Int, Sur.Re, Ad-Bo, Co	Grimes...[2-69]	Averaged
245	0.09	Double	5.3125	5200	1714	57.78	Ad-Bo, Sur. Re, Co	Grimes...[2-69]	
246	0.088	Double	5.3125	5275	1741	59.94	Ad-Bo, Int, Sur. Re	Grimes...[2-69]	
247	0.087	Double	5.3125	4245	1395	48.79	Ad-Bo, Int, Sur. Re	Grimes...[2-69]	
248	0.088	Double	5.3125	4907	1617	55.76	Ad-Bo, Int, Sur. Re	Grimes...[2-69]	Averaged
249	0.087	Double	5.50	4770	1353	54.83	Ad-Bo, Sur. Re	Grimes...[2-69]	(0450/45)= (0450/45)
250	0.089	Double	5.50	4080	1154	45.84	Ad-Bo, Sur. Re	Grimes...[2-69]	0' - Half a 0° ply
251	0.087	Double	5.50	6370	1800	73.22	Ad-Bo, Sur. Re	Grimes...[2-69]	
252	0.088	Double	5.50	5073	1436	57.65	Ad-Bo, Sur. Re	Grimes...[2-69]	Averaged
253	0.032, 0.032	Single	4.25	3065	1364	95.78	Sur. Re, Ad-Ti, Co, Int	Grimes...[2-69]	
254	0.032, 0.032	Single	4.25	2840	1262	88.75	Sur.Re,Ad-Ti,Co,Int,Ad-Bo	Grimes...[2-69]	
255	0.032, 0.032	Single	4.25	2480	1093	76.88	Sur.Re,Ad-Ti,Co,Int,Ad-Bo	Grimes...[2-69]	
256	0.032, 0.032	Single	4.25	2788	1240	87.13	Sur. Re, Ad-Ti, Co, Int	Grimes...[2-69]	Averaged
257	0.047, 0.045	Single	4.5625	1870	748	38.96	Ad-Bo, Sur. Re	Grimes...[2-69]	0' - Half a 0° ply
258	0.048, 0.045	Single	4.5625	2325	926	48.44	Ad-Bo, Sur. Re, Ad-Ti, Int	Grimes...[2-69]	
259	0.048, 0.045	Single	4.5625	2450	973	51.04	Sur. Re, Ad-Bo, Ad-Ti, Int	Grimes...[2-69]	
260	0.048, 0.045	Single	4.5625	2215	882	46.15	Ad-Bo, Sur. Re, Ad-Ti, Int	Grimes...[2-69]	Averaged



## Adhesive Lap-J

	H	I	J	K	L	M	N	O	P
261	0.031, 2x0.016	Double	2.75	4385	2181	146.17	Sur.Re,Ad-Ti,Ad-Bo,Int	Grimes...[2-69]	
262	0.030, 2x0.016	Double	2.75	4320	2145	144.00	Int	Grimes...[2-69]	
263	0.030, 2x0.016	Double	2.75	4475	2224	149.17	Sur. Re, Ad-Bo, Co,Int	Grimes...[2-69]	
264	0.030, 2x0.016	Double	2.75	4393	2183	146.43	Int, Sur. Re, Ad-Bo	Grimes...[2-69]	Averaged
265	0.080, 2x0.045	Double	3.4375	4205	1392	47.25	Sur.Re,Ad-Bo,Int,Co	Grimes...[2-69]	
266	0.080, 2x0.045	Double	3.4375	5740	1896	64.49	Ad-Bo,...	Grimes...[2-69]	
267	0.080, 2x0.045	Double	3.4375	5045	1667	56.69	Int,Sur.Re,Ad-Bo,Ad-Ti,Co	Grimes...[2-69]	
268	0.080, 2x0.045	Double	3.4375	4997	1652	58.15	Sur.Re,Ad-Bo,Int	Grimes...[2-69]	Averaged
269	0.080, 2x0.045	Double	3.6875	3715	1072	41.74	Ad-Ti, Sur. Re, Int	Grimes...[2-69]	0° - Half a 0° ply
270	0.080, 2x0.045	Double	3.6875	4385	1287	49.27	Sur. Rs, Ad-Ti, Ad-Bo	Grimes...[2-69]	
271	0.080, 2x0.045	Double	3.6875	3860	1133	43.37	Ad-Ti, Sur. Re, Int	Grimes...[2-69]	
272	0.080, 2x0.045	Double	3.6875	3987	1164	44.80	Ad-Ti, Sur. Re, Int	Grimes...[2-69]	Averaged
273	0.128, 0.042	Single	4.00	2630	5250	20.55	45-ply, Ad, 0-ply	Kelly [2-70]	Ti: Ti 6AL4V
274	0.128, 0.042	Single	4.00	2720	5450	21.25	0-ply, Ad, 45-ply	Kelly [2-70]	CARBOFORM, Ep:ERLA 4617/DDM
275	0.128, 0.042	Single	4.00	2250	4500	17.58	Ad, 0-ply, 45-ply	Kelly [2-70]	
276	0.128, 0.042	Single	4.00	2535	5070	19.80	Ad, 0-ply, 45-ply	Kelly [2-70]	Averaged
277	0.128, 2x0.042	Double	3.50	8039	4020	62.80	0-ply, Ad	Kelly [2-70]	Ti: Ti 6AL4V
278	0.128, 2x0.042	Double	3.50	5470	2735	42.73	Tens, Delamination	Kelly [2-70]	CARBOFORM, Ep:ERLA 4617/DDM
279	0.128, 2x0.042	Double	3.50	7960	3980	62.19	0-ply, 45-ply, Ad	Kelly [2-70]	
280	0.128, 2x0.042	Double	3.50	7156	3580	55.91	0-ply, Ad, Tens	Kelly [2-70]	Averaged
281	0.128, 2x0.042	Double	4.00	5800	5805	45.31	0-ply, Ad	Kelly [2-70]	Ti: Ti 6AL4V
282	0.128, 2x0.042	Double	4.00	5200	5205	40.63	0-ply, Ad	Kelly [2-70]	CARBOFORM, Ep:ERLA 4617/DDM
283	0.128, 2x0.042	Double	4.00	4360	4360	34.06	Ad, 0-ply	Kelly [2-70]	
284	0.128, 2x0.042	Double	4.00	5119	5125	39.99	0-ply, Ad	Kelly [2-70]	Averaged
285	0.128, 0.042	Single	4.00	2730	5450	21.33	0-ply, Ad	Kelly [2-70]	CARBOFORM, Ep:ERLA 4617/DDM
286	0.128, 0.042	Single	4.00	2860	5750	22.34	0-ply, Ad	Kelly [2-70]	
287	0.128, 0.042	Single	4.00	2795	5600	21.84	0-ply, Ad	Kelly [2-70]	Averaged
288	0.005	Single	10.5(T.L.)	1500	3000	300.00		Guess...[2-39]	ASTM D1002-72
289	0.005	Single	10.5(T.L.)	1590	3180	318.00		Guess...[2-39]	Averaged of 3 or more tests
290	0.005	Single	10.5(T.L.)	1655	3310	331.00		Guess...[2-39]	Averaged of 3 or more tests
291	0.005	Single	10.5(T.L.)	1525	3050	305.00		Guess...[2-39]	Averaged of 3 or more tests
292	0.005	Single	10.5(T.L.)	1570	3140	314.00		Guess...[2-39]	Averaged of 3 or more tests
293	0.25	Single	3.75(p-p)	4000	8000	16.00		Guess...[2-39]	Thick adherand test
294	0.25	Single	3.75(p-p)	3790	7580	15.16		Guess...[2-39]	Averaged of 3 or more tests
295	0.25	Single	3.75(p-p)	4030	8060	16.12		Guess...[2-39]	Averaged of 3 or more tests
296	0.25	Single	3.75(p-p)	3900	7800	15.60		Guess...[2-39]	Averaged of 3 or more tests
297	0.25	Single	3.75(p-p)	3940	7880	15.76		Guess...[2-39]	Averaged of 3 or more tests
298	0.25	Single	3.75(p-p)	3930	7860	15.72		Guess...[2-39]	Averaged of 3 or more tests
299	0.25	Single	3.75(p-p)	3700	7400	14.80		Guess...[2-39]	Averaged of 3 or more tests
300	0.25	Single	3.75(p-p)	3750	7500	15.00		Guess...[2-39]	Averaged of 3 or more tests
301	0.25	Single	3.75(p-p)	3710	7420	14.84		Guess...[2-39]	Averaged of 3 or more tests
302	0.50	Single	3.75(p-p)	4180	8360	8.36		Guess...[2-39]	Thick adherand test
303	0.50	Single	3.75(p-p)	4310	8820	8.62		Guess...[2-39]	Averaged of 3 or more tests
304	0.50	Single	3.75(p-p)	4320	8640	8.64		Guess...[2-39]	Averaged of 3 or more tests
305	0.50	Single	3.75(p-p)	4230	8460	8.46		Guess...[2-39]	Averaged of 3 or more tests
306	0.50	Single	3.75(p-p)	4180	8360	8.36		Guess...[2-39]	Averaged of 3 or more tests
307	0.50	Single	3.75(p-p)	4180	8320	8.32		Guess...[2-39]	Averaged of 3 or more tests
308	0.50	Single	3.75(p-p)	4060	8120	8.12		Guess...[2-39]	Averaged of 3 or more tests
309	0.50	Single	3.75(p-p)	4000	8000	8.00		Guess...[2-39]	Averaged of 3 or more tests
310	0.50	Single	3.75(p-p)	4150	8300	8.30		Guess...[2-39]	Averaged of 3 or more tests
311	1.00	Single	3.75(p-p)	4290	8580	4.29		Guess...[2-39]	Thick adherand test
312	1.00	Single	3.75(p-p)	4450	8900	4.45		Guess...[2-39]	Averaged of 3 or more tests
313	1.00	Single	3.75(p-p)	4280	8560	4.28		Guess...[2-39]	Averaged of 3 or more tests
314	1.00	Single	3.75(p-p)	4220	8440	4.22		Guess...[2-39]	Averaged of 3 or more tests
315	1.00	Single	3.75(p-p)	4170	8340	4.17		Guess...[2-39]	Averaged of 3 or more tests
316	1.00	Single	3.75(p-p)	4290	8580	4.29		Guess...[2-39]	Averaged of 3 or more tests
317	1.00	Single	3.75(p-p)	4000	8000	4.00		Guess...[2-39]	Averaged of 3 or more tests
318	1.00	Single	3.75(p-p)	4000	8000	4.00		Guess...[2-39]	Averaged of 3 or more tests
319	1.00	Single	3.75(p-p)	4100	8200	4.10		Guess...[2-39]	Averaged of 3 or more tests
320	0.005	Single	10.5(T.L.)	2290	4580	458.00		Guess...[2-39]	ASTM D1002-72
321	0.005	Single	10.5(T.L.)	2300	4600	460.00		Guess...[2-39]	Averaged of 3 or more tests
322	0.005	Single	10.5(T.L.)	2350	4700	470.00		Guess...[2-39]	Averaged of 3 or more tests
323	0.005	Single	10.5(T.L.)	2340	4680	468.00		Guess...[2-39]	Averaged of 3 or more tests
324	0.005	Single	10.5(T.L.)	2330	4660	466.00		Guess...[2-39]	Averaged of 3 or more tests
325	0.25	Single	3.75(p-p)	2910	5820	11.64		Guess...[2-39]	Thick adherand test



## Adhesive Lap-J

	H	I	J	K	L	M	N	O	P
326	0.25	Single	3.75(p-p)	3000	6180	12.38		Guess...[2-39]	Averaged of 3 or more tests
327	0.25	Single	3.75(p-p)	2710	5420	10.84		Guess...[2-39]	Averaged of 3 or more tests
328	0.25	Single	3.75(p-p)	2800	5600	11.20		Guess...[2-39]	Averaged of 3 or more tests
329	0.25	Single	3.75(p-p)	2650	5300	10.60		Guess...[2-39]	Averaged of 3 or more tests
330	0.25	Single	3.75(p-p)	2320	4640	9.28		Guess...[2-39]	Averaged of 3 or more tests
331	0.25	Single	3.75(p-p)	2710	5420	10.84		Guess...[2-39]	Averaged of 3 or more tests
332	0.25	Single	3.75(p-p)	2620	5240	10.48		Guess...[2-39]	Averaged of 3 or more tests
333	0.25	Single	3.75(p-p)	2300	4600	9.20		Guess...[2-39]	Averaged of 3 or more tests
334	0.50	Single	3.75(p-p)	3000	6000	6.00		Guess...[2-39]	Thick adherand test
335	0.50	Single	3.75(p-p)	2760	5520	5.52		Guess...[2-39]	Averaged of 3 or more tests
336	0.50	Single	3.75(p-p)	2850	5700	5.70		Guess...[2-39]	Averaged of 3 or more tests
337	0.50	Single	3.75(p-p)	2790	5580	5.58		Guess...[2-39]	Averaged of 3 or more tests
338	0.50	Single	3.75(p-p)	2790	5580	5.58		Guess...[2-39]	Averaged of 3 or more tests
339	0.50	Single	3.75(p-p)	2480	4960	4.96		Guess...[2-39]	Averaged of 3 or more tests
340	0.50	Single	3.75(p-p)	2750	5500	5.50		Guess...[2-39]	Averaged of 3 or more tests
341	0.50	Single	3.75(p-p)	2640	5280	5.28		Guess...[2-39]	Averaged of 3 or more tests
342	0.50	Single	3.75(p-p)	2490	4980	4.98		Guess...[2-39]	Averaged of 3 or more tests
343	0.50	Single	3.75(p-p)	2500	5000	5.00		Guess...[2-39]	Averaged of 3 or more tests
344	0.50	Single	3.75(p-p)	2420	4840	4.84		Guess...[2-39]	Averaged of 3 or more tests
345	1.00	Single	3.75(p-p)	2960	5920	2.96		Guess...[2-39]	Thick adherand test
346	1.00	Single	3.75(p-p)	2790	5580	2.79		Guess...[2-39]	Averaged of 3 or more tests
347	1.00	Single	3.75(p-p)	2760	5520	2.76		Guess...[2-39]	Averaged of 3 or more tests
348	1.00	Single	3.75(p-p)	2840	5680	2.84		Guess...[2-39]	Averaged of 3 or more tests
349	1.00	Single	3.75(p-p)	2600	5200	2.60		Guess...[2-39]	Averaged of 3 or more tests
350	1.00	Single	3.75(p-p)	2500	5000	2.50		Guess...[2-39]	Averaged of 3 or more tests
351	1.00	Single	3.75(p-p)	2340	4680	2.34		Guess...[2-39]	Averaged of 3 or more tests
352	1.00	Single	3.75(p-p)	2730	5460	2.73		Guess...[2-39]	Averaged of 3 or more tests
353	1.00	Single	3.75(p-p)	2430	4860	2.43		Guess...[2-39]	Averaged of 3 or more tests
354	1.00	Single	3.75(p-p)	2490	4980	2.49		Guess...[2-39]	Averaged of 3 or more tests

**Appendix C-1. Mechanical properties of composite laminae.**

Lamina Properties

A	B	C	D	E	F	G	H	I	J	K
Material	Fiber			Moisture	Longitudinal	Transverse		Poisson's	Longitudinal	Longitudinal
2 Fiber/Resin	Form	Volume	Temperature	Content	Modulus	Modulus		Tensile		Compression
3			% F	% wt	E11, Msi	E22, Msi				
4 Gr/EP AS4/3502	Unidirect.	61.5	75	0	20.87	1.72	0.97	0.326		
5 Gr/EP AS4/3501-6	Unidirect.	61.5	75	0	20.16	1.61	0.69	0.27		
6 Gr/EP T300/934	Unidirect.	75	0	20.0	1.7	0.66	0.29			
7 GVEP Scotchply 1002	Unidirect.	75	0	6.05	1.89	0.49	0.3			
8 GVEP Scotchply 1002	Unidirect.	75								
9 GR/PEEK ASA/APC-2	Unidirect.	75	0	19.44	1.29	0.74	0.28	308.9		
10 GR/PEEK XAS/APC-1	Unidirect.	75	0	17.56	1.47	0.67	0.37	263.6		
11 GR/PEEK ASA/PEEK	Unidirect.	75		18.51	1.49	0.87	0.32	308.9		
12 GR/PEEK ASA/PEEK	Unidirect.	150		18.78	1.39	0.78	0.33	311.3		
13 GR/PEEK ASA/PEEK	Unidirect.	250		18.59	1.20	0.71	0.32	302.4		
14 GR/PEEK ASA/PEEK	Unidirect.	350		18.49	0.71	0.41	0.34	293.3		
15 GR/PEEK ASA/PEEK	Unidirect.	75		19.69				236.4		
16 Gr/EP T300/914	Unidirect.	75		17.57				208.9		
17 Gr/EP AS1/3501-6	Unidirect.	75		18.85	1.9	0.85	0.30	230		
18 Gr/EP AS1/3501-6	Unidirect.	75		0.86	18.85	1.72	0.77	0.30	230	
19 Gr/EP AS1/3501-6	Unidirect.	250		0.86	18.54	1.27	0.60	0.30	236	
20 GVEP Scotchply 1002S	Unidirect.	75		7.18				261.6		
21 GVEP Scotchply 1002S	Unidirect.	75		7.59				255.0		
22 GVEP Scotchply 1002S	Unidirect.	75		6.69				203.2		
23 GVEP Scotchply 1002S	Unidirect.	160		6.54				177.1		
24 GVEP Scotchply 1002S	Unidirect.	-65		7.00				77.7		
25 GVEP XP251S	Unidirect.	75		7.67				247		
26 GVEP XP251S	Unidirect.	160		7.69				231.9		
27 GVEP XP251S	Unidirect.	-65		8.10				62.36		
28 GVEP XP251S	Unidirect.	75		8.33				143.6		
29 GVEP 143S/BP907	Woven	75		5.31				165.5		
30 GVEP 143S/BP907	Woven	75		4.50				139.7		
31 GVEP 143S/BP907	Woven	75		4.47				121.3		
32 GVEP 143S/BP907	Woven	160		3.81				115.1		
33 GVEP 143S/BP907	Woven	-65		5.20				78.7		
34 GVEP XP251S	Unidirect.	75		8.44				209.2		
35 GVEP XP251S	Unidirect.	75		8.50				146.4		
36 Gr/EP T300/1034-C	Unidirect.	75		21.3	1.65	0.89	0.3	251	200	
37 SGVEP SP-250/EP	Unidirect.	75		6.65	1.86	0.74	0.29	199.5	170	

Lamina Properties

	<b>L</b>	<b>M</b>	<b>N</b>	<b>O</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>
<b>1</b>	Transverse	Transverse	Shear	Longitudinal	Longitudinal	Transverse	Transverse	Thermal	Thermal	Reference
<b>2</b>	Tensile	Compression	Strength	Tensile Ult.	Compress. Ult.	Tensile Ult.	Compress. Ult.	Expansion Coeff	Expansion Coeff	
<b>3</b>	Strength, Y ksi	Strength, Y' ksi	S, ksi	Strain %	Strain %	Strain %	Strain %	a11(E-6)/°C	a22(E-6)/°C	
<b>4</b>	7.5	30	9.4					-0.899	23.0	Tan [3-1]
<b>5</b>								0.36	28.8	Tan [3-2]
<b>6</b>								0.05	16	Flaggs [3-3]
<b>7</b>										Highsmith... [3-4]
<b>8</b>								7.43	22.4	Pegano, Hahn [3-5]
<b>9</b>	11.6	29.0	23.2							Tan [3-6]
<b>10</b>	12.6	31.4	21.4							Tan [3-6]
<b>11</b>	13.8		11.9							Yoon, Sun [3-7]
<b>12</b>	12.3		9.9							Yoon, Sun [3-7]
<b>13</b>	9.4		7.7							Yoon, Sun [3-7]
<b>14</b>	5.8		5.2							Yoon, Sun [3-7]
<b>15</b>				1.16						Henaff-Gardin [3-8]
<b>16</b>				1.19						Henaff-Gardin [3-8]
<b>17</b>	9.5	38.9	17.3	1.22	1.76	0.54	2.91			Garbo, Ogonowski [3-9]
<b>18</b>		35.2	17.3	1.22	1.27					Garbo, Ogonowski [3-9]
<b>19</b>		26.0	11.0	1.27	0.83					Garbo, Ogonowski [3-9]
<b>20</b>										Cutler, Pinckney [3-10]
<b>21</b>										Cutler, Pinckney [3-10]
<b>22</b>										Cutler, Pinckney [3-10]
<b>23</b>										Cutler, Pinckney [3-10]
<b>24</b>										Cutler, Pinckney [3-10]
<b>25</b>										Cutler, Pinckney [3-10]
<b>26</b>										Cutler, Pinckney [3-10]
<b>27</b>										Cutler, Pinckney [3-10]
<b>28</b>										Cutler, Pinckney [3-10]
<b>29</b>										Cutler, Pinckney [3-10]
<b>30</b>										Cutler, Pinckney [3-10]
<b>31</b>										Cutler, Pinckney [3-10]
<b>32</b>										Cutler, Pinckney [3-10]
<b>33</b>										Cutler, Pinckney [3-10]
<b>34</b>										Cutler, Pinckney [3-10]
<b>35</b>										Cutler, Pinckney [3-10]
<b>36</b>	9.65		38.9	19.4						Chang, Chang [3-11]
<b>37</b>	8.59		30.0	13.8						Serabian, Op. [3-12]

## Lamina Properties

	A	B	C	D	E	F	G	H	I	J	K
38	Gr/Ep T300/N5208	Unidirect.		75	19.44	1.67	0.89	0.38	203.7	197.1	
39	Gr/Ep S-1014/N5208	Unidirect.		75	8.3	2.9	0.86	0.26	289.0	170.0	
40	Gr/Ep 1062/E-773FR	Unidirect.		75	5.78				153		
41	Gr/Ep 104 Scrim/5505	Unidirect.		75	3.2	1.7	0.93	0.15	37.8	45.4	
42	Gr/Ep 1581/N5505	Fabric		75	4.78				56.72		
43	Bo/Ep Boron/N5505	Unidirect.	53.6, [0]3	75	26.77		22.06	0.21	122.5		
44	Bo/Ep Boron/N5505	Unidirect.	49.8, [0]6	75	27.68		25.31	0.21	146.7		
45	Bo/Ep Boron/N5505	Unidirect.	51.2, [0]9	75	29.54				177.4		
46	Bo/Ep Boron/N5505	Unidirect.	50.1, [0]6	75	28.31				147.7		
47	Gr/PPS AS4/PPS	Unidirect.	56	75	22.6				333.0	195.3	
48	Gr/PEEK	Unidirect.	62	75	16.2				245.0	95.5	
49	Gr/Ep T300/976	Unidirect.	62	75	21.0				230.0	190.8	
50	IM6/F584 Tape	Unidirect.		75	23.0	1.25	0.7	0.33	343.4	202.7	
51	IM6/F584 Clo11	Unidirect.		75	10.1	0.55	0.071	142.8	86.4		
52	E-GF/F584 Ep	Unidirect.		75	2.1	0.7	0.18	51.0	65.3		
53	S-GF/F584 Ep	Unidirect.		75	3.1	3.6	0.7	0.18	120.0	150	
54	Gr/Ep GI/69	Unidirect.	67	75	7.98	3.77			159.5	130.5	
55	Gr/Ep GI/69	Unidirect.		75			0.73	0.23			
56	Gr/Ep GI/913	Unidirect.	60	75					169.7		
57	Gr/Ep GI/913	Unidirect.		75	6.09	2.18		0.227		108.8	
58	Gr/Ep XAS/913	Unidirect.	60	75					304.6		
59	Gr/Ep XAS/913	Unidirect.		75	21.76	1.38	0.263		174		
60	Gr/Ep XAS/914	Unidirect.	60	75					195.1		
61	Gr/Ep HTS/914	Unidirect.	60	75					174		
62	Gr/Ep HTS/HC3501	Unidirect.	60	75					179.3		
63	Gr/PEEK IM7/PEEK	Unidirect.	62.3	75	22.1	1.31	0.71	0.33	362.4	131.7	
64	Gr/Ep AS4/3502	Unidirect.		75	20.5	1.47	0.83	0.31	246.0	Buckling	
65	Gr/Ep AS4/3502	Unidirect.		250	19.7	1.27	0.75	0.30	222.0	Buckling	
66	Gr/Ep AS4/3502	Unidirect.		75	21.0	1.39	0.69	0.31	326.0		
67	Gr/PEEK AS4/APC-2	Unidirect.		75	20.0				300	175	
68	Gr/PEEK IM6/APC-2	Unidirect.		75	24.5				390	160	
69	Gr/PEEK IM7/APC-2	Unidirect.		75	24.5				420	160	
70	Gr/PEEK IM8/APC-2	Unidirect.		75	27.1				390	170	
71	Gr/PEEK CF/PEEK	Unidirect.		75	19.5				300	155	
72	Gr/PEEK S-2/APC-2	Unidirect.		75	8.0				170	160	
73	Gr/Ep AS4/3501-6	Unidirect.	62	75	0.0	20.0			230.2		
74	Gr/Ep AS4/3502	Unidirect.	62	75	0.0	21.5				280.2	

Lamina Properties

	L	M	N	O	P	Q	R	S	T	U
38	5.92	20.65	13.3							Hart-Smith [3-13]
39	11.0	29.0	9.0							Hart-Smith [3-13]
40										Poullios [3-14]
41	13.4		11.1							
42										Grimes... [3-15]
43	97.8									Grimes... [3-15]
44	174.6									Grimes... [3-15]
45	127.9									Grimes... [3-15]
46	120.1									Grimes... [3-15]
47			19.8							Grimes... [3-15]
48										Ong... [3-16]
49										Ong... [3-16]
50	7.1	37.4	20.2							Black... [3-17]
51	142.8	86.4	16.7							Black... [3-17]
52	51.0	65.3	16.7							Black... [3-17]
53	120.0	150.0	16.7							Black... [3-17]
54	8.27									Kretsis, Matthews [3-1]
55										Fothergill [3-19]
56										Kretsis, Matthews [3-1]
57	10.6	23.9								Ciba-Geigy [3-20]
58										Kretsis, Matthews [3-1]
59	8.27	22.5								Manufacturer
60										Collings [3-21]
61										Collings [3-21]
62										Collings [3-21]
63	12.2	24.3	23.3	1.52	0.64	1.03	1.80	-0.04	14.3 Silverman [3-22]	
64	7.31	Buckling	13.5	1.12	Buckling	0.50	Buckling		Liechti... [3-23]	
65	6.57	Buckling	11.0	1.08	Buckling	0.54	Buckling		Liechti... [3-23]	
66	11.09					1.44	0.77		Allen, Harris [3-24]	
67									[CI] [3-25]	
68									[CI] [3-25]	
69									[CI] [3-25]	
70									[CI] [3-25]	
71									[CI] [3-25]	
72									[CI] [3-25]	
73									Hercules [3-26]	
74									Hercules [3-26]	

Lamina Properties

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>K</b>
7.5	Gr/Ep AS4/3501-5A	Unidirect.	62	75	0.0	21.5					310.2
7.6	Gr/Ep AS4/1919	Unidirect.	62	75	0.0	20.0					320.2
7.7	Gr/Ep IM6/3501-6	Unidirect.	62	75	0.0	24.1					370.3
7.8	Gr/Ep IM7/8551-7	Unidirect.	62	75	0.0	23.9					449.6
7.9	Gr/Ep AS4/8552	Unidirect.	62	75	0.0	20.5					305.3
8.0	Gr/Ep AS4/A193-P	Fabric-Plain	62	75	0.0	10					100.1
8.1	Gr/Ep AS4/A280-5H	Fabric-Satin	62	75	0.0	10.4					100.1
8.2	Gr/Ep AS4/A370-5H	Fabric-Satin	62	75	0.0	10.4					100.1
8.3	Gr/Ep AS4/A370-8H	Fabric-Satin	62	75	0.0	10					90.1
8.4	Gr/Ep IM6/16360-5H	Fabric-Satin	62	75	0.0	13.9					146.1
8.5	Gr/Ep IM7/R6376	Unidirect.	75								415
8.6	Gr/Ep IM7/R6377	Unidirect.	75								410
8.7	Gr/Ep IM7/R6451	Unidirect.	75								255
8.8	Gr/Ep IM7/R6453	Unidirect.	75								330
8.9	Gr/Ep T300/Ep	Unidirect.	75								220
9.0	Gr/Ep T300/Ep	Unidirect.	75								390
9.1	Gr/Ep T300/Ep	Unidirect.	250								260
9.2	Gr/Ep T300/Ep	Unidirect.	350								260
9.3	Gr/Ep P75/Ep	Unidirect.	75								255
9.4	Gr/Ep P75/Ep	Unidirect.	75								220
9.5	Gr/Ep P75/Ep	Unidirect.	250								390
9.6	Gr/Ep T300/APCO 2447-2343	Unidirect.	66.0	75							220
9.7	Gr/Ep P75/APCO 2447-2343	Unidirect.	53.0	75							227.7
9.8	Kevlar 285	(0/90 weave)	60.0	75							61.1
9.9	Gr/Ep T300/5208	Unidirect.	55.0	75							21.1
10.0	Gr/Ep S2-GI/SP-250	Unidirect.	50.0	75							353.0
10.1	Ke/Polyester 281/F141	Fabric	55.7	75	4.77	4.77	0.21	0.05			28.2
10.2	Ke/Polyester 120/F141	Fabric	49.6	75	4.19	4.19	0.23	0.028			192.0
10.3	Boron/Ep	Unidirect.	50.0	75	30.0	2.7	0.7	0.21			264.0
10.4	Boron/Ep	Unidirect.	50.0	260	30.0	1.35	0.45	0.21			116.0
10.5	Boron/Ep	Unidirect.	50.0	350	29.9	1.13	0.32	0.21			157.0

## Lamina Properties

L	M	N	O	P	Q	R	S	T	U
7.5							Hercules	[3-26]	
7.6							Hercules	[3-26]	
7.7							Hercules	[3-26]	
7.8							Hercules	[3-26]	
7.9							Hercules	[3-26]	
8.0							Hercules	[3-26]	
8.1							Hercules	[3-26]	
8.2							Hercules	[3-26]	
8.3							Hercules	[3-26]	
8.4							Hercules	[3-26]	
8.5							Ciba-Geigy	[3-27]	
8.6							Ciba-Geigy	[3-27]	
8.7							Ciba-Geigy	[3-27]	
8.8							Ciba-Geigy	[3-27]	
8.9							Greszczuk	[3-28]	
9.0							Greszczuk	[3-28]	
9.1							Greszczuk	[3-28]	
9.2							Greszczuk	[3-28]	
9.3							Greszczuk	[3-28]	
9.4							Greszczuk	[3-28]	
9.5							Greszczuk	[3-28]	
9.6							Greszczuk	[3-28]	
9.7							Greszczuk	[3-28]	
9.8							Lamotte, Nunes	[3-29]	
9.9							Lamotte, Nunes	[3-29]	
10.0							Lamotte, Nunes	[3-29]	
10.1	73.4	21.1	7.92				Watson	[3-30]	
10.2	69.8	28.2	13.3				Watson	[3-30]	
10.3	10.4	40.0	13.0	0.65		0.40	4.14	19.08	Design Guide [3-31]
10.4	7.9	28.8	9.1	0.57		0.65	4.68	26.99	Design Guide [3-31]
10.5	8.0	11.0	7.0	0.54		0.76	5.39	35.28	Design Guide [3-31]